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LANDBOUNAVORSING
AGRICULTURAL RESEARCH
1985

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REPUBLIEK VAN SUID-AFRIKA
REPUBLIC OF SOUTH AFRICA

Departement van Landbou en Watervoorsiening
Department of Agriculture and Water Supply

LANDBOUNAVORSING
AGRICULTURAL RESEARCH
1985

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1984.04.01 - 1985.03.31

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OP	:	Veeartsenykunde (Onderstepoort)	Veterinary Science (Onderstepoort)
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TK	:	Tabak en Katoen	Tobacco and Cotton
WW	:	Wingerdbou en Wynkunde	Viticulture and Oenology
VV	:	Vrugte en Vrugtetegnologie	Fruit and Fruit Technology

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D	:	Oos-Kaap (Dohne)	Eastern Cape (Dohne)
T	:	Transvaal	Transvaal
V	:	Vrystaat	Free State
W	:	Winterreën	Winter Rainfall

PLANT PRODUCTION PROMOTION

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POTATOES

PATHOLOGY

TB.2411/19/3/1: VIRUS DISEASES OF POTATOES: DETECTION AND IDENTIFICATION OF POTATO VIRUS DISEASES. 1976-1984

P.J. Prins

The Sabie/Lydenburg potato plant improvement scheme was maintained free from the economically important viruses. As a result of continuous re-testing by means of reliable detection techniques, *viz* glasshouse indexing, A6-test, micro-agglutination test and the ELISA assay method, successful virus-free maintenance of the most important South African cultivars was possible. Antisera was prepared against potato viruses X, S, M and potato leafroll virus for the implementation of serological tests and currently used for the ELISA assay method.

The routine virus detection programme for the potato plant improvement scheme and the increasing requests from the industry and the Division of Plant and Seed Control, culminated in a lot of pressure on the Virus Section. An ELISA training course was then offered to utilise the commercially available ELISA kits. Six ELISA assay laboratories have since been set up by the potato seed growers, the Division of Plant and Seed Control and the Potato Board, and a further three laboratories will soon be operational.

A severe mosaic outbreak in the highest seed standard area with regard to occurrence of viruses (AA) of the Western Free State and Douglas, was positively identified as a new strain of potato virus Y. This is now under control, due to timely measures taken and the support given by two commercial laboratories in this region.

POTATOES

PATHOLOGY

TB.2411/19/3/2: VIRUS DISEASES OF POTATOES: THE ELIMINATION OF POTATO VIRUSES BY MEANS OF THERMOTHERAPY AND TISSUE CULTURE. 1976-1984

J.L.F. Dutrieux and Bela Vcelar

Between 1977 and 1982, 25 infected potato cultivars, both local and imported, and breeding lines have been successfully treated for virus elimination. This was achieved by using a combination of two methods, namely thermotherapy and meristem culture.

The success of these techniques is such that it has now become a routine action which will be incorporated under the responsibility of the Plant Improvement Section.

Thirteen other cultivars were found to be already virus-free. A nuclear stock of virus-free tubers of each cultivar and breeding line is being maintained by this Section at the Horticultural Research Institute.

Vegetables

TOMATOES

CROP SCIENCE

TB.2421/30/2/1: PRODUCTION OF TOMATOES UNDER PROTECTION. 1973-1983

E. Aucamp, O.J. Olivier, W.P. Stapelberg, P.J. Henrico and A.G. Comrie

The cultivation of tomatoes under protection in the Transvaal Middleveld was researched. It was ascertained that the type of tunnel covering has no significant effect on the adaptability, yield and quality of the harvest. The choice is one of economic importance.

The cultivars Hotset, Viresto and Estrella performed the best of the many cultivars tested. All the trials proved that it is impossible to produce tomatoes of satisfactory quality for marketing during the off-season (August to November) in tunnels containing no or partially controlled environments. The main reason is that the winter temperatures inside the tunnels are too low, restricting normal pollination and development of the fruits.

Heating of the soil with electrical cables, the use of thermal screens to contain heat radiation during the winter nights and raising the air temperature during the night with solar-heated water, cannot overcome the low night temperatures. Not only were the costs too high, but the required efficiency levels could not be obtained.

Tomatoes planted for marketing during winter (May to July) can successfully be produced in tunnels with no or partially controlled environment, such as adequate ventilation. The most important requirement is that the main flowering period must be completed before April 27. Seeding between January 28 and February 25 satisfies this requirement.

Truss pruning and a high potassium status of the soil have a slightly positive effect. The costs linked to truss pruning do not justify the advantages obtained.

The biggest problem concerning tunnel production is the successful marketing of the product. Tunnel tomatoes must compete with tomatoes that have been produced extensively on a large scale in the open.

Flowers and ornamental plants

BULB FLOWER CROPS

CROP SCIENCE

TB.2432/30/1/1: BULB FLOWER CROPS: MANIPULATION OF THE FLOWERING AND GROWING PERIOD OF *ORNITHOGALUM*. 1980-1984

D.I. Ferreira

The influence of storage temperatures and the period of storage on the flowering of *Ornithogalum thyrsoides* Jacq. was investigated. This was done to determine whether production of good quality flowers could be achieved outside the normal flowering season (September to November).

A total number of 91 different treatments were applied to the bulbs starting in February 1981. The parameters used were:

(a) Mass of the bulbs before planting.
(b) Number of days from the time of planting until the appearance of the first inflorescences.
(c) Number of days from the time of planting until the inflorescences were ready to be harvested.
(d) Mean number of inflorescences per plant.
(e) Mean length of the inflorescence stalk.
(f) Mean number of flowers per inflorescence.

The results of this investigation showed that *Ornithogalum* bulbs can be stored at a temperature of 30 °C for fairly long periods (25 weeks) under the conditions used in this investigation. If higher humidities can be maintained (without the development of diseases) the storage period can even be much longer. When

the humidity is not controlled the mass of the bulbs declines with an increase in the length of the storage periods.

The time lapse from planting until the inflorescences appeared and eventually developed to the stage at which they were harvested, was very definitely influenced by the storage temperatures as well as the duration of the storage. For example, bulbs which were stored at 30 °C for five weeks only flowered 200 days after they were planted, while those which were stored at 30 °C for 25 weeks, followed by a storage of five weeks at 18 °C and eventually five weeks at 11 °C, took only 92 days to flower. The treatments in the second stage (i.e. at moderate temperatures - 18 °C, 20 °C and 22 °C for five weeks) did not influence the growing period significantly, when compared with each other. The treatments in the third and final stage of storage (11 °C, 13 °C and 15 °C for five weeks) did influence the duration of the growing period up to flowering. The bulbs which were stored at 15 °C during the final stage, tended to have a longer growing period. As the duration of storage at 30 °C increased, the difference in time lapse among the various treatments also increased, with those stored at the higher temperatures during each stage having the longest growing periods. The deduction can therefore be made that the inhibitory effect of temperature on the development of the bulbs increased as the temperature increased from 11 ° to 30 °C.

The duration of the period of storage at 30 °C had a definite effect on the mean number of inflorescences produced per plant, as well as on the mean length of the inflorescence stalks. The number of flowers per inflorescence, however, varied to a lesser extent. If the duration of storage at 30 °C alone is considered, regardless of the follow-up treatments, the mean number of inflorescences per plant and the mean length of inflorescence stalks tended to increase from five to 15 weeks whereafter it decreased again.

Looking at the different treatments, regardless of the period of storage at 30 °C, it appears as if the higher storage temperatures enhanced the mean number of inflorescences per plant (treatments 1, 2, 3, 4 and 13). To some extent the same observations were made with regard to the mean number of flowers per inflorescence. Moderate temperatures (22 °C) during the second phase of storage seemed to have enhanced the mean lengths of the inflorescence stalks (treatments 4, 7, 10 and 12). From the treatments listed above it is clear that the temperatures during the final stage of storage also played a role. It seems as if temperatures above 13 °C during the final stage of storage, enhance the mean length of the inflorescence stalk.

Although it is not clear from the results of this investigation, the combination of 30 °C followed by 22 °C followed by 13 °C seems to be the most promising treatment.

It is, however, evident that the duration of the storage periods and maybe even the sequence of the second and third stages were not optimal. With regard to the three temperatures it can be concluded that storage at 30 °C inhibits the development of the bulbs; storage at 22 °C enhances the number of inflorescences as well as the number of flowers per inflorescence, while storage at 13 °C enhances the length of the inflorescence stalk.

CUT FLOWERS AND POT PLANTS

PESTS

TB.2433/20/1/1: A POPULATION SURVEY OF SCARABAEIDAE OCCURRING ON ROSES. 1976-1983

Jean M.I. Donaldson

The purpose of this project was to ascertain what species of Cetoniinae occurred in rural and suburban areas, the relative frequency of the different species and whether weather conditions influenced these populations. Also compost heaps in rural and suburban areas were examined to determine the beetles' breeding preferences.

The frequency of various species was different in rural and suburban areas. Prevailing temperature and heat units influenced the catch size of two of the commonest species in the rural area. For some species the timing of the peak catch was significantly correlated with certain meteorological conditions several weeks before the peak occurred. Graphs were drawn of the seasonal cycles of several species. *Pachnoda sinuata flaviventris* is the commonest species in suburban areas.

The difference between rural and suburban compost heaps is that the first mentioned contain animal dung, and the present results indicate that these are more attractive to species other than *P. s. flaviventris*. Also, in suburban areas compost is accumulated in numerous heaps that are not completely used, so that the cetoniine larval population builds up to a level which cannot be controlled by predators and parasites.

It is impossible to develop a method of predicting the seasonal variation of cetoniine beetle populations from meteorological data. Cetoniinae are pests of flowers and fruits only where collections of organic matter

(compost and/or dung) are allowed to accumulate. *P. s. flaviventris* is a pest in gardens of most suburban areas where it breeds in unused compost heaps.

CUT FLOWERS AND POT PLANTS

CROP SCIENCE

TB.2433/30/1/1: CUT FLOWERS AND POT PLANTS: STOCK/SCION AFFINITY STUDIES WITH ROSES. 1977-1984

D.I. Ferreira

It is evident that the stock/scion combination has an effect on both the number of flowers produced and, to a lesser extent, on the peaks of production. It is therefore possible to determine the best rootstock(s) for each cultivar as the best stock/scion combination can in some cases more than double the flower production. The results of this trial showed that the best rootstocks for the different cultivars are:

Eclipse	- Welch, Atwood and Basye 3
Carina	- Basye 3, Welch and Clarke 1952
Exciting	- Basye 3, Brooks 1948 and Prinshof 2
Happiness	- Basye 3, Welch and *Rosa manettii*
Mandrina	- Welch, Prinshof 2 and Clarke 1952
Pascali	- Prinshof 2, Brooks 1948 and Welch
Queen Elizabeth	- Basye 3, Prinshof 2 and Atwood

However, there are a few other factors that must be kept in mind, when choosing a suitable rootstock, for example: rooting ability, bud union and susceptibility to fungus diseases.

The determination of the best stock/scion combination for a specific cultivar can be of great value to nurserymen and cut-rose flower producers, and could even lead to greater popularity of the rose.

CUT FLOWERS AND POT PLANTS

TECHNOLOGY

TB.2433/52/1/1: CUT FLOWERS AND POT PLANTS: POST-HARVEST PHYSIOLOGICAL AND STORAGE STUDIES ON ROSES. 1979-1983

D.I. Ferreira

This investigation was carried out, in the first instance, in order to determine which biochemical, physiological and ultrastructural changes occur in the senescing rose petals of *Rosa hybrida* L. cultivar 'Sonia'. Secondly, a flower preservative has been developed in order to inhibit the senescence of cut rose flowers. The effectiveness of the flower preservative was tested by determining the influence of the preservative on the vase life of nine other rose cultivars, namely, 'Baccara', 'Carina', 'Ilona', 'Golden Fantasy', 'Golden Times', 'Lara', 'Pascali', 'Prominent' and 'Tommy Bright'. Quantitative determinations were carried out on the changes in starch content, total free reducing sugar concentration and the total free amino acid concentration, while the changes in membrane permeability (determined as percentage apparent free space - % AFS) and the cell ultrastructure (determined electron microscopically) were also determined, to compare physiological and cytological events. The respiration climacteric was used as a standard for determination of the degree of senescence.

Seven different chemicals were tested for the preservation of cut rose flowers, namely: silver nitrate ($AgNO_3$), 8-hydroxy-quinoline sulphate (8-HQS), citric acid, sucrose, urea, hexamine and polyvinyl-pyrrolidone (PVP). Not all these chemicals had beneficial effects on the vase life of rose blooms. The final flower preservative contained 2,5 mg $AgNO_3$ + 130 mg 8-HQS + 200 mg citric acid + 30 g sucrose/ℓ of deionised water. The vase life of the blooms of the ten different cultivars when kept in the preservative instead of in deionised water was increased, and in some cases ('Sonia', 'Golden Fantasy', 'Pascali' and 'Tommy Bright') even doubled. However, the preservative was only effective if the flowers were kept in it for at least 36 h, whereafter the preservative could be filled up with water, daily. The flower preservative was also more effective when at least three or four leaves were left on the flower stem, instead of

two or less.

The changes in the respiration rate of petals of senescing roses clearly showed a typical climacteric. The climacteric rise coincided with an increase in the membrane permeability, and it seemed as if the climacteric rise was caused by the loss of the integrity of the cells. The mitochondria retained their normal appearance during the final stages of senescence, and the decrease in the respiration rate of flowers kept in deionised water, can therefore be ascribed to a shortage of substrates for respiration. The final decrease in the respiration rate of flowers in the preservative, however, can probably be ascribed to structural changes of the mitochondria, together with a decrease in the control of respiration. No relationship was found between the respiration rate and the vase life of the blooms, and the theory that flowers with a high respiration rate would have a short vase life, could not be confirmed. The blooms in the preservative had a higher rate of respiration throughout the period of senescence, when compared with blooms kept in deionised water, probably because of the exogenous supply of sucrose.

The flowers in the deionised water initially showed a sharp decrease in the starch content, whereafter a more gradual decrease was observed. Simultaneously the initial total free reducing sugar concentration stayed fairly constant, whereafter an increase was observed, possibly because of the hidrolysis of the starch. The initial total free amino acid concentration also stayed fairly constant, whereafter an increase occurred, possibly because of the degradation of protein. The changes in the starch content, total free reducing sugar concentration, and the total free amino acid concentration of rose blooms in the preservative, showed almost the same tendencies. The decrease in the starch content, however, was more gradual, while the increase in the total free reducing sugar concentration was much higher. The total free amino acid concentration stayed fairly constant throughout the period of scenescence, except for an increase towards the end of the period of senescence. This increase, however, was smaller than that of the blooms kept in deionised water, possibly because of the fact that less protein was hydrolised, owing to the high concentration of reducing sugars which could be used as substrates for respiration. Starch granules were observed in the plastids of blooms kept in the preservative up to a later stage than in the plastids of blooms kept in deionised water.

The initial rise in the water content up to a maximum during the preclimacteric minimum, can probably be ascribed to the availability of an unlimited water supply. The decrease in the water content occurred faster in blooms kept in deionised water than in those in the preservative. It is assumed that the decrease was caused by plugging of the stems, and the preservative therefore inhibited this plugging.

The membrane permeability, determined as percentage apparent free space, increased throughout the period of senescence of blooms kept in deionised water and the flower preservative, except for a decrease which occurred prior to the onset of the respiration climacteric. The changes in the membrane permeability showed a close relationship to the changes of the tonoplast in the cells. The increase in the % AFS coincided with a degeneration of the tonoplast, while the decrease in the % AFS during the preclimacteric stage, coincided with a recovery of the tonoplast structure.

Senescence of rose petals is a complex process during which biochemical, physiological and ultrastructural changes occur according to a definite pattern. This process can be inhibited, but not prevented, by a flower preservative.

Pome and stone fruits

APPLES

PHYSIOLOGY

VV.2441/03/2/1: PHYSIOLOGY OF DIE-BACK OF APPLES IN WET SOIL CONDITIONS. 1982-1984

A.F. Lourens

In the past two seasons fruit and plant material of apples were analysed in order to find a reliable indicator for waterlogging conditions and to determine any possible detrimental effect of waterlogging on fruit quality.

In the first season it was found that with young trees grown in pots, the bark of waterlogged Starking trees had a higher ethanol content than those of Golden Delicious and Granny Smith. The difference in ethanol content between "dry" and "wet" trees was however not significant. In orchard trees no such differences could be determined.

During the second season a comprehensive study was done in orchard as well as full-grown potted trees

under dry and waterlogged conditions, respectively. Soil moisture determinations seem to be the only reliable method to indicate waterlogged conditions. High CO_2 and ethylene levels in soil atmosphere are not necessarily related to waterlogging and ethanol content of bark of young shoots shows no significant difference.

No significant differences in fruit quality or chemical composition could be found between fruit from dry and waterlogged sites either in pots or orchards. The fruit from wet plots seemed to be bigger, better coloured and with a higher sugar content than fruit from dry plots.

APPLES

PATHOLOGY

VV.2441/19/1/5: MUCOR ROT IN COLD-STORED APPLES. 1981-1983

J.C. Combrink

In a series of expriments the development and control of decay of apples caused by *Mucor piriformis* Fischer were studied. The following aspects were investigated: occurrence of *M. piriformis* colony-forming units in dump tank water, pathogenicity of sporangiospores at different inoculum levels and temperatures, mode of infection and *in vitro* and *in vivo* efficacy of chlorine as control measure.

The water of only 12% of the dump tanks surveyed, contained more than 100 *M. piriformis* colony-forming units/cm^3. An increase in inoculum level from 10^3 to 10^5 sporangiospores/cm^3 did not appreciably increase the level of infection, which suggested that the virulence of the isolate was low. Temperature affected infection significantly. In Starking and Golden Delicious apples most decay developed at 5,5 °C and in Granny Smith at 20 °C. Decay also developed at -0,5 °C. Infection took place through skin breaks and the level of infection was directly proportional to the size of the skin break. In the absence of skin breaks, no infection occurred.

Chlorine was effective *in vitro* and *in vivo*. At a concentration of 50 mg/dm^3 available chlorine or higher, 80% or more of all exposed spores were killed after an exposure time of 30 s. Chlorination with 25 mg/dm^3 available chlorine of water containing spores of *M. piriformis*, decreased the incidence of decay developing at lesions on Starking, Golden Delicious and Granny Smith by 33% to 57%.

It was concluded that mucor rot can be effectively controlled by careful handling, applying chlorine to dump tank water and by prompt and rapid pre-cooling to -0,5 °C.

APPLES

TECHNOLOGY

VV.2441/52/1/2: INFLUENCE OF PRE-HARVEST AND PRE-COOLING FACTORS ON KEEPING QUALITY: IDENTIFICATION OF FACTORS INDUCING BRUISING WITH GOLDEN DELICIOUS APPLES. 1979-1981

G.J. Eksteen

This facet extended over three seasons and consisted of both field and laboratory experiments. The first series of field tests proved that:

- Bruising increases as the apples mature in spite of a decrease in available soil moisture over the same period
- Apples picked during the early morning are more susceptible to bruising than apples picked later during the day
- Apples cold-stored for less than 5 days are more susceptible to bruising than apples stored longer than this period
- Bruise susceptibility is not related to physical characteristics such as turgor pressure, fruit firmness and cell elasticity
- Most bruising occurs on the sorting and grading machines but can be reduced considerably by effective padding of contact points

During the second series of tests it was proved that:

- Wilting of the fruit at ambient conditions prior to cold storage did not affect bruise susceptibility but may induce bitterpit and yellowing
- The least bruising was found in apples cold-stored for more than 7 days

From the above it was concluded that Golden Delicious apples must be pre-cooled immediately after harvesting to -0,5 °C and then stored at this temperature for at least 7 days to allow moisture loss at a low temperature. This procedure was checked in two commercial cold stores and proved to be valid under commercial conditions.

The series of laboratory tests proved that the 6 % tolerance of unacceptable bruising is reached when Golden Delicious apples are subjected to a vertical drop exceeding 33 mm, or when the vertical speed of the apple before contact with a solid object exceeds 0,56 $m.s^{-1}$. In practice this means that drop height and belt speed should not exceed these values. These results were also checked in a commercial packing house and it was concluded that bruising can be reduced tenfold by reducing sorting and grading speed.

Minor bruises became visible when the underlying cortex tissue turned brown. If the fruit temperature is kept close to 0 °C browning is reduced considerably. It was also established that browning can be reduced by lowering the temperature of fruit that had warmed up during the packing and handling process.

The results of all these experiments were also checked under commercial conditions and found to be valid in practice. The recommendations made to the industry are generally applied with good success. Research on this topic is therefore terminated.

PEACHES

PHYSIOLOGY

VV.2443/03/3/1: BUD DEVELOPMENT AND BUD DROP IN PEACHES. 1983

A. Rabie

Abscission of flower buds and young fruits in the Kakamas peach cultivar sometimes results in the loss of up to 80 % of the potential fruitlets. A wide range of factors could induce flower buds of peaches to drop and it is quite possibly an interaction between several factors which eventually causes the drop.

The relationship between shoot length, aspect (eastern and western side of the trees), height above ground and bud drop prior to anthesis was investigated and it has been found that there is a correlation between different heights and bud drop (possibly because the buds at different heights received different amounts of light). Bud drop in this case occurs as a result of the formation of an abscission zone and not as the result of abnormal bud development. External differences between buds which will drop and those which will not drop can only be observed when the buds swell prior to anthesis. Buds which will drop do not swell because their further development ceases. These buds drop after a few days.

Energy dispersion spectrometry-, triphenyltetrazolium chloride tests and microchemical tests were performed in an attempt to localise the differences between the abscission zone and surrounding tissue at an early stage. The abscission zone can be observed at light microscopic level when abscission preceded by cell division, commences. As abscission progresses, successive changes in cellular organisation are clearly perceptible. Bud abscission as it occurs in the peach prior to anthesis, corresponds in many respects to leaf abscission where a mobilisation phenomenon and cellular senescence take place during the course of abscission.

PEACHES

PHYSIOLOGY

VV.2443/03/3/2: EFFECT OF GROWTH SUBSTANCES ON RIPENING OF PEACHES. 1982-1984

H. Tormann

Various growth substances such as Alar, 2,4,5,-TP and Promalin, alone and in combination, have been tested on nectarines, plums and apricots during the past two seasons. The object was to shorten the ripening period. No positive results could, however, be obtained. In some cases, as with Alar and 2,4,5-TP, the ripening of nectarines and apricots was enhanced, but with a detrimental effect on the keeping quality.

PEACHES

PHYSIOLOGY

VV.2443/03/4/2: WOOLLINESS OF PEACHES. 1980-1984

L.J. von Mollendorff

A study was undertaken to determine whether any relationship exists between the development of woolliness and various changes in the biochemical composition and activity of different pectic enzymes in peaches (*Prunus persica*, cv. Peregrine). The study also included an anatomical examination of the tissue of both normal fruit and fruit that developed woolliness.

Although the total moisture content of the fruit remained relatively constant during the storage and ripening period, the free moisture content and the firmness of the fruit decreased rapidly concomitant to the development of woolliness.

The ethylene content of woolly peaches was lower than that of non-woolly peaches throughout the entire storage and ripening period. The sugar content of non-woolly peaches on the other hand, increased on the whole until the 15th day of storage and then decreased slowly. In contrast the development of woolliness led to a progressive increase in sugar during the ripening period.

The viscosity of the soluble pectins attained a maximum value during the development of woolliness, whereas in non-woolly fruit, maximum viscosity of the soluble pectins was observed much earlier. This higher viscosity appears to be due to the presence of higher molecular mass pectins.

The dolygalacturonase (PG) activity of peaches stored directly at low temperatures (woolly peaches) was markedly lower during the first 21 days than that of the peaches which were initially subjected to the delayed storage period and which did not develop woolliness. A sharp increase in the PG activity of the peaches which developed woolliness, was observed during the ripening period.

An anatomical examination of woolly and non-woolly fruit tissue showed that the cells of woolly peaches became detached from each other, whereas cells in the non-woolly peaches remained firmly bound.

No significant differences in the total calcium content were observed between woolly and non-woolly peaches, although the ionic calcium content increased rapidly during the development of woolliness, possibly as a result of the release of calcium from the cell walls.

It would appear that soluble pectins of relatively high molecular mass are formed as a result of the low PG activity during the storage, followed by a sharp increase in activity during the development of woolliness. In the presence of a high sugar content, it is probable that pectin sugar-gels are formed which lead to the characteristic dry flesh of woolly fruit.

PEACHES

UPGRADING

VV.2443/07/1/4: BREEDING AND SELECTION OF PEACHES FOR THE SUMMER RAINFALL REGION. 1956-1983

E.P. Evans

Prior to the establishment of the Horticultural Research Institute at Roodeplaat in 1949, peach production in the summer rainfall area was not of great importance owing to the lack of adapted cultivars. Most of the cultivars grown there were imported and were either poorly adapted or produced fruit of inferior quality.

In a trial at Roodeplaat mainly imported cultivars were planted in 1949 in an effort to determine the potential and adaptability of these cultivars. Of the 116 cultivars evaluated, 17 were reasonably well adapted but only four (all of South African origin) produced fruit of good quality and were suitable for commercial production.

The lack of well-adapted cultivars for the relatively mild winters of the summer rainfall area, motivated the Department of Agriculture to start a breeding programme in 1956 to develop low-chilling cultivars for this area. The winter chilling varies from 100 to 850 h below 7,0 °C and it was therefore necessary to breed for specific climatic areas. Other aims of this programme were to develop cultivars which would

(i) ripen earlier than the existing cultivars

(ii) flower late, thus escaping frost damage (a problem in the Eastern Free State and Northern Cape areas).

During the breeding period 87 893 hand pollinations were made and 25 109 seedlings raised. Forty-three cultivars and 74 selections were used as parents. Five hundred and sixty-nine seedlings were retained for a more critical evaluation. Eleven cultivars emanated from this breeding programme. These are Orion, Earlibelle, Albatros, Sunray, Golden Amber, Ingwe, Safari, Clocolan, Ficksburg, Imperani and Rolees.

The release of the white-fleshed dessert cultivars Orion and Earlibelle has advanced the early peach season by two weeks. These cultivars require very little winter chilling and are even being grown in certain parts of the Transvaal Lowveld.

The yellow-fleshed dessert peaches Sunray, Golden Amber, Ingwe, Safari and Imperani ripen from mid-November to early January and have filled a gap during this period. Previously only one yellow-fleshed peach cultivar, namely Jubilee which ripens at the end of December, was grown on a limited scale.

The cultivars Clocolan, Imperani and Rolees were specifically bred for the Eastern Free State area where late frost often is a problem. These cultivars flower during the latter part of August and usually escape frost damage. Imperani has become one of the most important cultivars in that area. Rolees, which was released in 1982, is considered to be superior to Kakamas as a dessert peach.

Certain cultivars and selections are recommended for use as parents to develop nectarines and yellow-fleshed dessert peaches for the summer rainfall area of South Africa where the winter chilling varies from 100 to 900 h below 7,0 °C.

PEACHES

PATHOLOGY

VV.2443/19/1/1: NUMERICAL TAXONOMIC ANALYSIS AND BIOLOGICAL CONTROL OF *AGROBACTERIUM TUMEFACIENS* OF PEACHES. 1978-1983

H.J. du Plessis

Seventy-three South African and 17 reference *Agrobacterium* strains were studied in terms of phytopathogenicity, numerical analysis of phenotypic characters, and polyacrylamide gel electrophoresis (PAGE) protein patterns. The feasibility of biological control of crown gall in South Africa by *Agrobacterium radiobacter* strain 84, by an agrocin 84-producing transconjugant (*A. radiobacter* strain 625/11) and by bacteriocinogenic agrobacteria from soil, was determined.

Numerical analysis of 47 phenotypic characters distinguished the 90 *Agrobacterium* strains in three clusters (biotypes) at a 65 % similarity level. Seventeen different phenotypic groups which included 11 known genetic races of *Agrobacterium* species were also distinguished at a 90 % similarity level.

Diagnostic phenotypic characters determined in this study, could be a useful and practical guide for the identification of *Agrobacterium* isolates from affected plants and from soil. However, PAGE was the most valuable and reliable technique for identifying, grouping and indicating genetic relationships of the strains investigated.

Fifty-one per cent of 69 South African phytopathogenic *Agrobacterium* strains were sensitive to agrocin 84 produced by *A. radiobacter* strain 84. Biological control studies on tomato seedlings and on other host plant species showed that crown gall in South Africa can be controlled by strain 84, provided it is caused by agrocin 84-sensitive strains.

The high percentage (49 %) of agrocin 84-resistant *Agrobacterium* strains found in South Africa led to the conclusion that a search for additional antagonists, effective against all or most South African crown gall agrobacteria, should be undertaken. However, none of 30 bacteriocinogenic agrobacteria isolated from soil, prevented indicator *Agrobacterium* strains from causing tumours on tomato stems. A biotype 1, agrocin 84-producing transconjugant (strain 625/11) controlled the phytopathogenic *Agrobacterium* strains on tomato stems in a manner comparable to strain 84.

Until other effective antagonists are found, the possibility that strain 625/11 might assist strain 84 in the biological control of crown gall in South Africa should receive further attention.

PEACHES

CROP SCIENCE

(S)WP.252/1: PRODUCTION SYSTEMS AND CROP CONTROL: PRUNING OF KAKAMAS TYPE PEACH TREES TO OBTAIN SMALLER TREES AND A LONGER PRODUCTIVE LIFE. 1971-1981

O. Bergh

Kakamas canning peaches on seedling roots were spaced at 4,8 m x 6 m and trained to the pyramid and vase shapes at the Bien Donné Experiment Farm. Two pruning treatments were applied, namely summer pruning and winter pruning. A split plot design was chosen, consisting of eight tree plots, two main treatments and two sub-treatments, replicated three times. Summer pruning consisted of the removal of water shoots and superfluous growth during early November and a complete and final pruning during March. Winter pruning was done during July and standard methods were followed. Care was taken to remove an equal amount of new growth from each of the summer and winter treatments at pruning time.

Results proved that pyramid-shaped trees were extremely difficult to train with this vigorous and whippy cultivar, especially in a windy area like Bien Donné with the prevailing South-easter. Fairly drastic pruning was necessary during the first three years to arrive at the correct shape and trees had to be staked. Pyramid-shaped trees could not be trained without additional summer pruning and the winter pruning treatment was supplemented during the first three years with summer pruning. The drastic summer pruning resulted in a significant reduction of the trunk cross-sectional area as compared to the vase-shaped trees but there was only a slight reduction in the yield per tree. It was proved that the percentage bud drop was significantly reduced by summer pruning treatments and this explained the slight reduction of the yields to some extent. Bud drop was a serious problem in the experimental orchard and was also found to exist in most orchards in the area where adequate chilling hours were lacking.

Contrary to results obtained in some co-operative trials where significant increases in yield occurred after a summer pruning programme was applied, this could not be proved in the trial. No significant differences were found between summer or winter pruned trees. This could be explained by the fact that the orchard suffered a severe setback owing to extremely wet soil conditions during 1976, and vigour was impaired to such an extent that shading of trees which normally results at these dense spacings did not occur. It was proved that summer pruning could have no beneficial effect under such conditions and could be dangerous owing to the dwarfing effect and thus reduced leaf area. The trial has, however, proved that a closer spacing of the Kakamas type trees is possible and such trees can be maintained at such a spacing by means of the summer manipulations. Optimum production in the trial orchard exceeded 40 t/ha, which was considerably more than in the conventionally spaced 6 m x 6 m orchards in the area where the production seldom exceeds 20 t/ha.

APRICOTS

UPGRADING

VV.2445/07/1/4: BREEDING OF APRICOTS FOR THE SUMMER RAINFALL AREA. 1977-1983

T.K. Haulik

The object of the breeding program was to develop new apricot cultivars for the summer rainfall areas, suitable for the fresh market. This involved controlled and open-pollinated crosses between existing cultivars such as Bulida, Royal and Early Cape (*Prunus armeniaca* L.).

None of the seedlings proved to be outstanding regarding crack resistance, fruit size or yield. 3 040 seedlings were evaluated and discarded thus indicating that the probability of obtaining crack-resistant apricot cultivars by breeding with presently available genetic material only is very small. To solve this major problem (cracking of fruit) in the summer rainfall areas, imported material which is genetically crack resistant should be incorporated.

TABLE GRAPES

Berry fruits

BERRIES

UPGRADING

VV.2451/07/1/5: BREEDING AND SELECTION OF STRAWBERRIES FOR THE SUMMER RAINFALL REGION. 1955-1983

E.P. Evans

Strawberries are the most important berry crop grown in South Africa. During the pre- and early post-World War II period the South African strawberry industry was mainly dependent on imported cultivars. These cultivars were poorly adapted in the summer rainfall area and therefore produced poor yields of inferior fruit. Yields varied from 3 to 5 t/ha and the average berry mass was only 5,0 g. Nevertheless, strawberry production was of great importance to many farmers in this area during those years. For instance, 93 t of the 100 t sold on the major South African markets in 1957/58 was produced by growers in this area and sold on the Pretoria and Johannesburg markets. In view of the importance of this crop in this area and the great need which existed for well-adapted cultivars, a breeding programme was started in 1955 at the Horticultural Research Institute to improve the yield, fruit size, firmness, flavour and attractiveness of existing cultivars.

During the 1955-1983 breeding period, seven cultivars were bred and released for this area. The cultivars Robyn, Karmyn and Selekta were released during the 1964-1973 period, whereas Rolinda, Rolissa, Rorine and Rovelle were released in 1983.

At present Selekta is the most important cultivar in this area and 65 % of the estimated 120 ha are planted to Selekta. Selekta produces good yields of large (12,6 g), firm and attractive berries.

The latest releases, however, are more attractive than the commercial cultivars Selekta, Parfaite and Tioga. The yield varies from 38 to 54 t/ha and the fruit size is comparable to that of Selekta. Rolissa, Rorine and Rovelle are firmer than Selekta and Tioga. It is expected that the 1983 releases will continue to stimulate the strawberry industry in the summer rainfall area. Some of these cultivars should be more suitable for export than existing cultivars.

The impact of the South African bred cultivars can be seen in the volume increase of strawberries sold on the Johannesburg and Pretoria markets in recent years. Two years after the breeding programme was started, the average tonnage handled by these markets was a mere 93 t, compared to the 860 t valued at R903 335,00 for the 1977-1981 period. If the volume of strawberries used for processing and sold directly to the public is also taken into account, it is estimated that approximately 1 200 t valued at R1,2 million is now being produced in the summer rainfall area.

During this breeding period 45 important overseas cultivars were imported and evaluated at the Horticultural Research Institute. Only Earlibelle and Tioga were reasonably well adapted in the summer rainfall area. At present Tioga accounts for less than 10 % of the total production in that area. The disappointing results obtained with these imported cultivars highlights the significant value of a local breeding programme.

Viticulture

TABLE GRAPES

PHYSIOLOGY

VV.2461/03/1/1: PHYSIOLOGY OF ROOTING AND CALLUS FORMATION IN THE VINE. 1976-1981

D.C. Uys

Several facets with regard to the accumulation and utilisation of reserve nutrients related to propagation of the grapevine were studied.

Seasonal changes in carbohydrate and nitrogen fractions in the shoots (canes) of the mother vine and the effect of the composition of the canes on the callusing and shoot and root growth performance of cuttings taken from them

The developing shoots on Jacquez and Salt Creek mother vines were sampled at monthly intervals and divided into six regions. The seasonal changes in dry mass, sugar, starch, hemicellulose, total N and soluble N were recorded. On August 2 (Southern Hemisphere) samples of cuttings for callusing and rooting were taken from each of the six regions. The callusing performance and shoot and root growth were correlated with the various components.

Sugar + starch + hemicellulose as concentration of fresh mass increased in all shoot regions, reaching peaks on May 3 in Salt Creek and June 1 in Jacquez. This was followed by small losses in Jacquez during June and considerable losses in Salt Creek during May and June. During July general small increases took place.

Of the three carbohydrate fractions studied, hemicellulose was the first to start accumulating, reaching peaks on February 2 (% of fresh mass). This was followed by losses after which a second series of peaks was reached on May 3 in Salt Creek and June 1 in Jacquez. This was followed by considerable losses.

On the basis of sugar and starch concentrations of fresh mass, the season can be divided into two distinct stages. The first stage started after bud-break and continued until end May to early June. During this stage sugar remained at a fairly constant level around 1-2 %, the excess sugar being converted to starch and other products. The second stage, which covered the period early June to early August, was characterised by the conversion of starch to sugar during which sugar increased substantially while starch decreased. Throughout the season starch was generally higher in the primary shoot regions than in the secondary shoots. On August 2 the final date, the sugar + starch concentration was considerably higher in Jacquez than in Salt Creek.

Initial high total N concentrations (based on fresh mass) decreased to low values around February and March, subsequently showing a steady increase until August 2. Soluble N followed the same basic pattern as total N in Jacquez. In Salt Creek soluble N also decreased until February 2, followed by a sudden increase until March 1 and a loss of the same magnitude until April 1. From then onwards the increase was slower than that of Jacquez, resulting in Salt Creek reaching only about 50 % of the corresponding values recorded in Jacquez on August 2.

The Jacquez cuttings from different regions showed no significant difference in callusing or shoot and root growth, nor did these show any statistically significant correlation with any of the variables. The Salt Creek cuttings from different regions showed a statistically significant difference in callus score and the latter was also positively correlated with cutting mass.

Effect of cutting date and cold storage of Jacquez and Salt Creek cuttings on the carbohydrate levels and callusing performance

Cuttings were collected at the beginning of May to September and analysed and callused immediately. Other cuttings were collected on the first three dates and cold-stored at 0 °C until August 1 when they were callused or analysed for sugar, starch and hemicellulose. Best callusing at the apex was obtained in cuttings collected on May 2, and second best in those collected on September 1.

Callusing performance was affected to a lesser extent by carbohydrate concentration than by other undetermined factors. Cold storage generally depressed callusing performance, and the longer the period of storage the greater was its effect.

Effect of callusing period and degree of callusing on the levels of carbohydrate and nitrogen fractions and other macro-elements in different regions of cuttings and scions, as well as the respiration rate of cuttings after callusing for 21 days

Apart from the initial sampling, cuttings of Jacquez and Salt Creek and scions of Waltham Cross were callused for 7, 14 and 21 days. The callusing cuttings and scions sampled after 14 and 21 days were separated into "good" and "poor" callusing groups. All sampled cuttings were then divided into four regions. The samples were analysed for sugar, starch, hemicellulose, total and soluble N, P, K, Ca and Mg, the analytical results being expressed as concentration of initial dry mass and as total content per cutting. Further groups of cuttings of Jacquez and Salt Creek were callused for 21 days, divided as above, and the respiration rate of each region at 25 °C subsequently determined.

The largest carbohydrate losses from the whole cutting or scion comprised sugar in Jacquez and sugar

and starch in Salt Creek and Waltham Cross. Losses of sugar + starch + hemicellulose from Salt Creek were considerably higher than from Jacquez over the full period. During this period little change occurred in the total N content, but that of soluble N increased substantially. With the exception of Mg in Salt Creek which increased marginally, P, K, Ca and Mg were lost from all three cultivars.

The pattern of changes in sugar, starch and hemicellulose concentration in the four regions of Jacquez and Salt Creek was basically similar, which indicates that they were depleted or accumulated to the same extent in all regions. This further indicates that the higher respiration rates obtained in the basal region (BR) and apical region (AR) were partly maintained by the utilisation of sugars translocated from other regions. These sugars were immediately utilised for respiration and no accumulation took place.

Total N in Jacquez and Salt Creek showed increases in the BR during callusing, while the concentration of soluble N and other macro-elements hardly differed between regions. The "good" and "poor" callusing groups exhibited few differences in respect of all the above-mentioned components.

Effect of callusing temperature on the degree of callusing and carbohydrate utilisation

Apart from the initial sampling, cuttings of Jacquez and Salt Creek were callused at 15 °, 20 °, and 25 °C for 28 days, after which the callus was scored and the cuttings analysed for sugar, starch and hemicellulose. Results were expressed as concentration of initial dry mass.

Callusing was best at 25 °C, slightly poorer at 20 °C and none occurred at 15 °C. In both cultivars callusing was poorer at the apex than at the base, with Jacquez showing a tendency towards better callusing at the apex and poorer callusing at the base than in the case of Salt Creek. The loss of sugar + starch + hemicellulose was positively related to the callusing temperature, Salt Creek showing a lower percentage loss at the two lower temperatures than Jacquez; at 25 °C, however, the percentage loss was about the same in both cultivars.

Effect of cutting length on callusing and carbohydrate utilisation

Apart from the initial sampling, cuttings of Jacquez and Salt Creek of the following lengths were callused for 28 days at 25 °C: 200-250 mm with buds, 80 mm with one bud in the middle, and internodes of 80, 40, 20 and 10 mm. Samples were analysed for sugar, starch and hemicellulose.

Final sugar concentration differed little between cutting lengths, but final starch concentration was positively related to cutting length. The presence or absence of a bud in the 80 mm cuttings had no statistically significant influence on the utilisation of sugar + starch, or on callusing at the base or apex. Cutting length influenced callusing at the base, the shorter cuttings callusing less; bud had no effect on callusing at the apex.

Seasonal changes of carbohydrate fractions during the nursery stage

Cuttings of Jacquez and Salt Creek grown in a sandy soil were sampled for analysis over the full growing season. The sampling dates were as follows: August 19 (before planting), September 2, 16, 30, October 14, 28, November 11, 25, December 22, January 22, February 23, March 22, May 24 and July 23. The samples were analysed for sugar, starch and hemicellulose and results expressed on an absolute basis as well as concentration of dry mass.

In both cultivars shoot growth started before root growth, but the latter developed at a greater rate and on July 23 the dry mass ratio of roots to shoots was 3,2:1 for Jacquez and 1,7:1 for Salt Creek. The cuttings were dependent on their sugar, starch and hemicellulose reserves for a period of 12 weeks after planting. Starch concentration in the stem (cutting) subsequently increased rapidly while sugar concentration remained at a constant low level. Hemicellulose increased concomitantly with starch in the stem. The roots were the most important part for starch storage, while in the shoots hemicellulose was the dominating of the three carbohydrate components.

Effect of growth period and *α*-indole butyric acid (IBA) treatment on the levels of carbohydrate and nitrogen fractions and other macro-elements in different regions of cuttings (plants) as well as the respiration rate of the different regions after growing at 18 °C for 21 days

The treatments consisted of control Jacquez and Salt Creek cuttings and others of which the basal

10 mm had been dipped in 1 000 mg/ℓ IBA for 5 min. Apart from an initial sampling of untreated cuttings, cuttings of all treatments were planted in acid-washed sand to be sampled after 7, 14, 28, 42 and 56 days. Planting was done on October 28 at which stage the weather conditions were warmer, and this allowed the changes to be followed in a shorter period. Deionised water was used for irrigation. All sampled plants were divided into four regions and in these the dry mass, sugar, starch, hemicellulose, total and soluble N, P, K, Ca and Mg were determined. Analytical results were expressed as content per region and for the whole plant. Further groups of cuttings treated similarly were grown at 18 °C in sand for 21 days, divided as above, and the respiration rate of each region at 18 °C in the dark was subsequently determined.

The plants lost dry mass until the final sampling, the losses varying between 7,6 and 10,6 %. IBA treatment had no significant effect on dry mass losses. The largest losses in the whole plant were incurred by sugar and starch, but some hemicellulose was also utilised, showing that at least part of the hemicellulose had served as a reserve carbohydrate. IBA treatment had very little effect on the utilisation of the carbohydrate fractions in the whole plant over the full period. In the whole plant there was a loss of total N, P, K, Ca and Mg. Soluble N in Jacquez showed little change, but in Salt Creek it increased during the first 7 days. IBA treatment hardly affected the loss of total N, P, K, Ca and Mg.

In all plant regions the sugar + starch + hemicellulose content was depleted to about the same extent over the full period, but there were some mutual transformations between the fractions, resulting in some changes in the distribution of the fractions in the plant. For instance, sugar content in the basal regions changed little in the untreated cuttings but actually increased over the full period in the IBA-treated cuttings.

From a comparison of respiration rates after 21 days and the loss of sugar + starch + hemicellulose it can be deduced that a translocation of carbohydrates in the form of sugars from the middle to the apical and basal regions of the plants must have occurred. IBA treatment stimulated respiration in the BR of Jacquez and Salt Creek.

Three of the elements N, P and K showed more mobility in the plant with translocation mainly towards the apical region. Ca and Mg showed less mobility, but also a translocation in the same direction. IBA treatment of Jacquez had little effect on translocation of the mobile elements when compared to the control. In Salt Creek IBA stimulated translocation of these elements to the basal region. The sink/source relationship was therefore changed by the IBA treatment.

IBA treatment had a larger stimulatory effect on the formation of soluble N in the Jacquez than in the Salt Creek. This effect was stronger nearer to the base where the IBA had been applied.

TABLE GRAPES

PATHOLOGY

WW.2461/19/1/1: SURVIVAL SOURCES OF *BOTRYTIS CINEREA* OF TABLE GRAPES AND FACTORS WHICH INFLUENCE SPORE DISPERSAL. 1978-1984

A.C. Thomas

The epidemiology of *Botrytis cinerea* Pers. ex Nocca & Balb. was studied under South African conditions. Isolates from grapevines and weeds from vineyards were identified as *B. cinerea* according to morphological characteristics and cellular fatty acid profiles. The effect of temperature, pH and water potential on growth and sclerotium production was determined *in vitro*. The effect of temperature, wetting period and relative humidity on infection was determined in greenhouse experiments.

Infection of ripe berries began after a 4-h wetting period, infection of old leaves after a 24-h wetting period and young leaves after a 50-h wetting period. After a wetting period of 66 h or longer, a higher percentage young leaves than old leaves became infected. The abaxial sides of leaves were more susceptible to infection than the adaxial sides. Stomatal penetration was observed but direct penetration through anticlinal cell walls was more prevalent. Wounding of the epidermis predisposed leaves to infection.

Differences in susceptibility between cultivars were found, but grapes from cultivars with resistant leaves were not necessarily resistant to *Botrytis* infections. Sugar content, pH and cuticle thickness of berries could not be correlated to disease resistance. It was proved by artificial inoculation that shoots became infected in autumn through leaf scars.

WINE GRAPES

TABLE GRAPES

TECHNOLOGY

VV.2461/52/1/1: UPTAKE OF SO_2 BY TABLE GRAPES. 1978-1981

Julia C. Laszlo

The project extended over a period of three years and included Waltham Cross and Barlinka grapes packed in the standard export polyethylene bag pack. Three different gas generators were used. In 1978 and 1979 the commercial generator contained 0,38 g to 0,55 g sodium metabisulphite per sheet. In 1980 two different generators were used; 0,40 g to 0,45 g sodium metabisulphite per sheet for Barlinka and 0,30 g to 0,35 g metabisulphite per sheet for Waltham Cross. Pre-cooling was delayed for 12, 24 and 36 h after packing at a temperature of 20 °C in 1978 and 1979, and at temperatures of 18 and 27 °C in 1980. The SO_2 concentration inside the bag was checked after 1, 2, 3, 4, 12, 24 and 36 h. Total SO_2 absorbed by grapes was determined at the same time and at weekly intervals during 1-month storage at -0,5 °C. Bleaching injury and rot decay were evaluated after three weeks at -0,5 °C plus one week at 10 °C.

When a generator containing 0,38 g to 0,45 g metabisulphite per sheet was used the SO_2 concentration increased rapidly to more than 250 ppm within 2 h after the bag was sealed. Then the concentration decreased to almost zero after 36 h of packing. At 27 °C, when generators containing less sodium metabisulphite were used, a maximum of 180 ppm SO_2 was reached after 2 h of closing the bag. In this case the decrease in SO_2 concentration was rapid and virtually no SO_2 could be detected in the bag after 24 h. At 18 °C packing temperature the release of SO_2 was much slower and more even. A concentration of 35 to 40 ppm SO_2 could be maintained in the bag for at least 22 h. The total SO_2 content in the grapes reached 18 to 22 ppm during the first 2 h and remained more or less constant after 36 h. A rapid decrease in SO_2 content took place during the first week of storage at -0,5 °C then the SO_2 concentration stabilised at 8 to 10 ppm.

WINE GRAPES

NUTRITION

WW.2462/05/1/4: THE EFFECT OF ROOTSTOCK/SCION COMBINATIONS ON UPTAKE AND TRANSLOCATION OF NUTRIENTS. 1979-1982

W.J. Conradie

The experiment was conducted on two-year old Chenin blanc vines in 45 ℓ pots. The vines were grafted on 99 Richter, 101-14 Mgt and 140 Ruggeri and fed with standard Hoagland solution. At the end of rapid shoot growth (December) ^{15}N labelled KNO_3 was applied to four vines on each of the three rootstocks through the Hoagland solution. These vines were sampled at véraison and separated into the following fractions: rootstock trunk, scion trunk and cordons, medium roots (diameter $<$ 2 mm), fine roots (diameter $>$ 2 mm), shoots (current growth), leaf blades, leaf petioles, marc (skins, pip and stalks) and juice. The samples were analysed for N, P, K, Ca and Mg, using standard methods, while the ^{15}N content was determined on an atomic emission spectrophotometer.

Effect of rootstocks on general growth

The dry mass of the rootstock trunk and roots produced by 99R was significantly lower than that of 140 Ruggeri and 101-14 Mgt. The vines on 99R also showed less shoot and leaf growth than those on 101-14 Mgt.

Effect of rootstocks on leaf and must composition

The total nitrogen contents of leaf blades, petioles and must were not affected by different rootstocks but it was clear that the 99R induced high phosphorous contents while 101-14 Mgt tended to give the lowest values. Furthermore, the must from vines on 101-14 Mgt showed a higher K content which, through higher pH values, may indirectly lead to wines of inferior quality.

Distribution of nitrogen

The 99R rootstock trunk accumulated a significantly larger fraction of the absorbed nitrogen than 101-14 Mgt, but apart from that the distribution of nitrogen in all other organs was remarkably similar for the three rootstocks despite differences in mass. This shows that the relatively small mass of roots produced by 99R under the conditions of this experiment, was just as effective in the absorption of nitrogen as the significantly larger masses of roots found for 101-14 Mgt and 140 Ruggeri. More than half of the absorbed nitrogen was retained in the leaves and shoots, while the bunches accumulated a much smaller fraction (11,5-16,1 %).

Translocation of nitrogen

It was calculated that newly absorbed nitrogen only accounted for about one quarter of the nitrogen accumulated in the bunches between the end of active shoot growth and véraison. It was therefore clear that the bunches depended heavily on the pool of previously assimilated nitrogen in the roots and mature wood. The ratio of newly absorbed/previously assimilated nitrogen was not affected by rootstock cultivar.

WINE GRAPES

PATHOLOGY

WW.2462/19/1/8: WOOD DECAY OF GRAPEVINE: SURVEY OF FACTORS INFLUENCING WOOD DECAY. 1978-1981

J.H.S. Ferreira and J.A. Sutherland

A survey of the occurrence of wood decay in existing trials of different cultivars and rootstocks as well as cultivation methods was conducted to determine the effect of these factors on wood decay. Bunch counts and yield data were also used to determine the economic importance of this disease. Diseased vines had a significantly lower yield in comparison with visually healthy vines. Further results also indicated that although typical disease symptoms were absent on some vines in a diseased vineyard, these seemingly healthy vines had a wood decay incidence of 13 % in comparison with the 29 % of vines showing typical symptoms.

Results indicated that fertilisation as well as different cultivation practices had no effect on the incidence of wood decay. Indications were that white cultivars were more susceptible to wood decay than red cultivars. Owing to the seasonal difference in disease incidence between rootstock cultivars no comment can be made as to the influence of rootstocks on the susceptibility of the scion cultivar to wood decay.

WINE GRAPES

PESTS

WW.2462/20/2/1: CHEMICAL CONTROL OF BUD MITE ON VINE GRAPES. 1979-1983

C.A. de Klerk

The vine bud mite is an increasing problem in almost all viticultural areas in South Africa, causing deformed leaves, shoots and bunches as well as poor growth and yield. According to many farmers, insufficient chemical control is obtained with the registered products. Two field trials were therefore conducted in different areas to test various chemicals against this pest as well as to ascertain the correct time and number of applications per season and the volume of spray mixture per vine in the Paarl area.

Applications of chlorobenzilate (Akar) 50 % ec at 50 mℓ/100 ℓ water and propoxur (Unden) 20 % ec at 125 mℓ/100 ℓ water resulted in good control. Both chemicals are registered for the control of the vine bud mite. The best results were obtained with three applications per season at 14-day intervals starting at bud burst. The standard recommendation was two applications per season at 14-day intervals starting at 10 cm shoot length. The results also showed that at least 500 mℓ spray mixture per vine must be applied for successful control. Vine bud mite control must be applied for at least two successive seasons.

Successful control was also obtained in large vineyard blocks, commercially sprayed with a blower pump according to these recommendations. To reduce the loss of spray mixture early in the season, hand

guns are recommended. If a blower pump must be used, the nozzles should be adjusted to direct most of the spray mixture onto the buds and shoots.

WINE GRAPES

CROP SCIENCE

WW.2462/30/2/2: OPTIMAL CROP LOAD FOR WINE GRAPES ON DIFFERENT TRELLISING SYSTEMS AT ROBERTSON: CHENIN BLANC. 1979-1983

L.J. Jooste

All the measured parameters except shoot length and shoot mass were significantly influenced by bud load elevation. An increase in bud load per m^2 soil surface area caused an increase in crop and a decrease in bud fertility but had no significant effect on the leaf surface area per vine. A leaf surface area to fruit mass ratio substantially smaller than 10-14 cm^2/g fruit was sufficient to ripen the crop of Chenin blanc vines. Neither the rate of sugar accumulation and reduction in must acidity nor the wine quality was negatively influenced by the high bud loads. The reproductive lifespan of the vines was reached and the experiment had to be terminated before the optimum bud load for Chenin blanc vines could be determined.

WINE GRAPES

CROP SCIENCE

WW.2462/30/3/2: THE EFFECT OF LIMING ON SOIL CHARACTERISTICS AND PERFORMANCE OF ROOTSTOCK CULTIVARS FOR WINE GRAPES. 1976-1982

W.J. Conradie

The experiment was conducted in 45 *l* earthenware pots. The growth medium consisted of the subsoil layer from a Clovelly soil form with a pH of 4,1. The unlimed soil was used as control and evaluated against two treatments limed to pH values of 5,0 and 6,0, respectively. Chenin blanc vines grafted on 15 rootstock cultivars were planted in the pots during October 1977 to give an experimental layout of 15 rootstocks x 3 soil treatments x 3 replicates. The vines were watered whenever the moisture content dropped to approximately 50 % of field capacity. During the 1980/81 season samples for leaf analyses were taken. At the end of the season the vines were sampled destructively and separated into one-year-old shoots, thick roots (diameter $>$ 2 mm), fine roots (diameter $<$ 2 mm) and trunk (consisting of rootstock trunk, scion trunk and all scion wood older than one year). All fractions were dried and mass-measured, while the one-year-old shoots were also analysed chemically. Soil strengths were determined for 12 randomly selected pots (four at each of the three soil treatments) with the aid of a portable recording penetrometer. The soils were chemically analysed for pH, Ca, Mg, K, P, Al and cation exchange capacity (CEC).

Effect of liming on soil characteristics

The pH values as measured at the end of the four-year experiment showed that acidification of the soils occurred during the course of the experiment. In accordance with these lower pH values there was an increase in the Al content of the control sample. Initial liming to a pH of 6,0 eliminated exchangeable Al completely, while the soil initially limed to a pH of 5,0 showed an Al content of 0,15 meq/100 g, which is still well below the figure of 0,2 meq/100 g, generally accepted to be the value above which Al becomes toxic. However, in view of the re-acidification which occurred during the relatively short duration of this experiment farmers should add appreciably more lime during soil preparation than the amount necessary to increase the pH to 5,0. Liming also had a beneficial effect on soil strength, which was consistently lower for limed soils than for the control.

Effect of liming on shoot growth

Significant differences were found among soil treatments for the shoot masses of Chenin blanc grafted

on the 15 rootstock cultivars. On average the vines in the soil initially limed to pH 5,0 showed an increase of 27 % in shoot growth in comparison with the control, against an increase of 87 % over the control for the soil limed to pH 6,0. There were considerable differences in shoot mass between individual rootstocks, with 140 Ruggeri and USVIT 8-7 performing the best on the unlimed soil, and 1103 Paulsen, 44-53 Malegue, USVIT 3-6 and 101-14 Mgt yielding the lowest shoot mass. Liming to an initial pH of 5,0 had a small effect on the performance of rootstocks which did relatively well on the unlimed soil but increases in shoot masses ranging from 70 % to 200 % were shown for the rootstocks with the poorest performances on the unlimed soil. Further liming to a pH of 6,0 caused increased shoot masses for all rootstocks with the exception of USVIT 8-7.

Effect of liming on root growth

Liming did not affect root masses as much as it did shoot masses, but vines on the soil limed to pH 5,0 still showed an increase of 10,8 % for total root mass when compared to the control. Vines from the soil limed to pH 6,0 averaged a significant increase of 31,9 % in root mass over the control. The increase in total root mass was mainly due to an increase in fine roots and on average vines from the pH 6,0 treatments showed 39,7 % more fine roots than the control, while thick roots were only 20,3 % more. This finding may be ascribed to the lower soil strengths found for the limed soils and/or lower Al toxicity.

As in the case of shoots, the root growth of rootstock cultivars differed significantly in their reaction to lime. The rootstocks not adapted to acid soil conditions (Rupestris du Lot, S04, 44-53 Malegue and 101-14 Mgt) reacted highly positively to the addition of lime and all showed increases of more than 75 % for total root mass when vines from the soil limed to a pH of 6,0 are compared to the control. These increases were in all cases mainly due to a larger mass of fine roots.

Effect of liming on nutrient content of shoots and leaves

The nutrient contents of shoots and leaves varied considerably among soil treatments and from cultivar to cultivar. However, no consistent pattern was discernable and the results gave no clear evidence as to which of the nutrient elements were involved in the poor performance of vines on acid soils.

WINE GRAPES

CROP SCIENCE

WW.2462/30/4/2: THE EFFECT OF ROOT PRUNING THROUGH PERIODICAL DEEP CULTIVATION AND THE BIOLOGICAL STABILISATION OF THE NEWLY CREATED SOIL STRUCTURE, ON THE PERFORMANCE OF WINE GRAPES: ROBERTSON. 1980-1983

L. van Huyssteen

Three periods and two intensities of root pruning with the wiggle plough were compared, *viz*:

- Control - no root pruning
- Root pruning at budding in every row
- Root pruning at flowering in every row
- Root pruning after harvest in every alternative row
- Root pruning after harvest in every row

Two cover crops, wimmera rye grass and vetch, were used for stabilisation of the newly formed structure. There were two wimmera plots - on one chemical weed control was done and on the other mechanical clean cultivation was practised. The vetch plots were sprayed with herbicides. The two wimmera sub-plots received 100 kg limestone ammonium nitrate additional to the normal annual fertilisation. Overhead sprinklers were used to apply blanket irrigations.

It was very difficult to establish cover crops successfully under the large trellising systems owing to shading in autumn.

No clear trends in vine performance could be established owing to the poor vine growth and continuous dying of experimental vines, which made it difficult to draw sound conclusions. Likewise, results

on must and leaf analyses were difficult to interpret. However, it seemed as if clean cultivation induced higher P contents in the vines than did minimum cultivation. The petioles from the plots on which roots were pruned after harvest contained more N than the petioles from the plots where roots were pruned at flowering.

The wiggle plough is an effective implement for soil loosening in the middle of the row.

DRYING GRAPES

PHYSIOLOGY

WW.2463/03/1/1: INFLUENCE OF TEMPERATURE OF THE SUBSOIL ON ROOT DEVELOPMENT AND PRODUCTION OF CYTOKININ OF *VITIS* IN THE CASE OF RAISIN GRAPES. 1976-1983

L.J. Jooste

The aim of this study was to determine the influence of soil temperature on the growth and cytokinin metabolism of vines, as well as its possible relationship to the growth arrestment phenomenon.

Under controlled conditions one-year-old, rooted, single-bud cuttings were used as planting material. Under field conditions eleven-year-old vines of Sultana, Chenin blanc and Sultana grafted on Rupestris du Lot and 420-A Mgt rootstock cultivars were used.

Tests for the quantification of cytokinins were examined and the best results were obtained with the soybean callus bio-assay.

By the measurement of plant growth parameters it was shown that under laboratory conditions different vine cultivars responded differently to soil temperature. Vines of all the investigated cultivars have generally shown the lowest performance at 10 °C and the highest at 30 °C. Sultana and Constantia Metallica vines, in contrast to the other two cultivars, could not sustain vigorous shoot growth at 20 °C soil temperature for a period longer than seven weeks.

The fact that the vine root is an important source of cytokinins to the aerial part of the plant was confirmed by this study. The synthesis and transport of cytokinins to the aerial part of the plant were restricted by a 10 °C soil temperature. Information on the cytokinin activity in the flower bunches of adult vines has shown that there is no block in the cytokinin transport system from the roots to the aerial part of any of the investigated vines. A significantly higher cytokinin activity was present in the exudate of Chenin blanc and Sultana/Rupestris du Lot than in that of Sultana and Sultana/420-A.

The results of this study have shown that the growth arrestment phenomenon of Sultana cannot totally be ascribed to low soil temperature and an insufficient metabolism of cytokinins in the roots of the vines. A combination of other factors may also be involved in the occurrence of this phenomenon.

DRYING GRAPES

TECHNOLOGY

VV.2463/52/1/1: GRAPES FOR DRYING - IMPROVEMENT OF QUALITY OF HANEPOOT RAISINS BY TREATMENT OF THE VINES WITH HORMONES AND DEVELOPMENT OF BETTER DRYING TECHNIQUES. 1981-1984

G.L. Wium

The quality of raisins prepared from grapes collected in different vineyards was evaluated after drying in the sun. The raisins from five vineyards were judged superior to the others in terms of appearance and other characteristics, but these samples contained too many small-sized raisins. For various reasons the experiments to improve berry size could not be concluded.

Addition of various detergents to standard cold lye did not improve the quality of raisins prepared by dehydration of hanepoot grapes.

Oenology

WINE

CHEMISTRY

WW.2471/53/1/1: SIFTING OF VOLATILE COMPONENTS IN WINE WITH RESPECT TO WINE QUALITY: CHENIN BLANC. 1981-1984

P.C. van Rooyen

Three grape maturity indices, *viz* degrees Balling (°B), total titratable acidity (TTA) and the B.pH product of musts were compared regarding their ability to predict optimum quality for Chenin blanc and Colombar wines. Comprehensive analytical data from 168 musts and corresponding wines for the 1978, 1979 and 1980 vintages from the Stellenbosch, Robertson and Lutzville areas were accumulated, and subjected to principal component analysis using variables and variable ratios selected by correlation to quality weighting.

These results indicated that the two cultivars differed appreciably with respect to the value of all three measured indices. From this study it was not possible to select a specific index to predict optimum maturity in all cases. Optimum values for each index differed according to geographic locality.

WINE

CHEMISTRY

WW.2471/53/1/2: SIFTING OF VOLATILE COMPONENTS IN WINE WITH RESPECT TO WINE QUALITY: COLOMBAR. 1981-1984

P.C. van Rooyen

Three grape maturity indices, *viz* degrees Balling (°B), total titratable acidity (TTA) and the B.pH product of musts were compared regarding their ability to predict optimum quality for Chenin blanc and Colombar wines. Comprehensive analytical data from 168 musts and corresponding wines for the 1978, 1979 and 1980 vintages from the Stellenbosch, Robertson and Lutzville areas were accumulated, and subjected to principal component analysis using variables and variable ratios selected by correlation to quality weighting.

These results indicated that the two cultivars differed appreciably with respect to the value of all three measured indices. From this study it was not possible to select a specific index to predict optimum maturity in all cases. Optimum values for each index differed according to geographic locality.

Citrus and subtropical crops

CITRUS

PATHOLOGY

SS.2481/19/1/2: CONTROL OF BACTERIAL DISEASES OF CITRUS: PATHOGENICITY OF THE GREENING ORGANISM. 1971-1983

J.N. Moll

Three aspects of citrus greening in South Africa were investigated:

- The presence of the greening organism in and transmission by *Trioza erytreae* (Del Guercio)
- Structure and taxonomy of the incitant
- Alternate herbaceous hosts for greening were investigated and the organism was transmitted to periwinkle.

Micro-organisms identical to those seen in phloem of greening infected citrus were found in adults of *T. erytreae*, the psylla vector of citrus greening, observed to be a phloem feeder.

CITRUS

Electron microscopy of adult psylla fed on greening-infected sweet orange seedlings for 30 days revealed high concentrations of the greening organism in the haemolymph, and limited numbers within muscles and nerves as well as salivary gland cells, whence presumably it is introduced with saliva into healthy citrus.

Very few organisms were present in the haemolymph of adult psylla after feeding on infected seedlings for 21 days, and none was found in psylla fed for 30 days on healthy plants.

T. erytreae adults fed for only 5 days on infected foliage and then transferred to healthy material for a further 25 days, likewise contained large concentrations of the greening organism in the haemolymph, indicating that the organism multiplies in the vector. The inability of psyllid nymphs to acquire or transmit the organism is tentatively ascribed to slow penetration of the insect gut wall by the greening organism which is thus discarded with the foregut at each moult. Although the greening organism is able to penetrate insect membrane barriers, no signs of extensive tissue damage in the insect host could be detected, not even in the tissues adjacent to large concentrations of the organism.

The cell envelope of the greening organism varies in width from 20 to 30 nm and comprises an outer triple-layered membrane-like structure and an inner cytoplasmic membrane, separated by an electron transparent zone. An *in situ* comparative ultrastructural study of the greening organism and a plant pathogenic mycoplasma-like organism (MLO), two rickettsia-like organisms (RLO) causing phony peach disease and clover club leaf, and the Gram-negative bacteria *Xanthomonas campestris* and *Pseudomonas solanacearum*, revealed that the envelope of the greening organism bears no resemblance to the single membrane delimiting MLO's or the very thick envelope of the RLO causing phony peach disease. It is concluded that the outer membrane-like structure and the adjacent electron transparent zone of the greening organism envelope together constitute a cell wall resembling that of Gram-negative bacteria, but differing in that no R-layer is present. Although the envelope of the RLO causing clover club leaf is similar to that of the greening organism, the membrane-like outer structure of the former displays a distinctive, darker inner layer which is possibly the site of mucopeptide. The presence of this darker layer indicates that despite their similarities the greening organism and the RLO causing clover club leaf are different types of organisms.

The organism was artificially transmitted to a new host, *Catharathus rosea* which provides a much higher titre and a faster turnover in infected plants. It also provides a better source of inoculum for isolation studies because of its higher titre.

Despite the fact that Kochs postulates were not formally proven, this research delivers strong evidence linking a Gram-negative bacterium to the occurrence of greening disease.

CITRUS

CROP SCIENCE

SS:2481/30/3/2: INFLUENCE OF CITRUS SCION/ROOTSTOCK COMBINATIONS ON THE GROWTH OF SUBSEQUENT COMBINATIONS. 1971-1982

W.P. Burger

The purpose of this pot experiment was to determine the effect of nine citrus scion/rootstock combinations, grown for four years in potted virgin soil, on the subsequent replant crop of the same scion-rootstock combinations in the same soil.

Three scion cultivars, Palmer navel, Olinda valencia and Marsh grapefruit, were used in combination with three rootstock cultivars, i.e. Rough lemon, Troyer citrange and Empress mandarin.

Virgin soil from the Sundays River Valley, prone to the replant problem, was used as potting medium.

Total shoot growth of the second planting was recorded after 8 months growth.

The results indicate that practically all scion/rootstock combinations of the first planting suppressed the growth of the subsequent planting by 0 to 84 % in comparison with the growth in the control soil in which no citrus was grown previously.

Empress mandarin, Troyer citrange and Rough lemon rootstocks, respectively, caused 51 %, 47 % and 38 % reduction in the growth of subsequent test plants.

Owing to the great variation in growth of individual plants, no definite conclusions can be drawn with regard to the reaction of specific scion/rootstock combinations in the replant crop.

AVOCADO

PATHOLOGY

SS.2483/19/1/1: VEGETATIVE REPRODUCTION OF RESISTANT AVOCADO CULTIVARS. 1971-1983

J.N. Moll

This research was initiated when the avocado industry was virtually moribund owing to the ravages of root rot caused by the fungus *Phytophthora cinnamomi*. At that stage no effective chemical control of the fungus was available.

Very little resistant rootstock material was available and nurserymen were encountering great difficulty in vegetatively reproducing it by the published techniques.

A new commercial technique was developed by which Duke 6 and Duke 7 could be vegetatively reproduced on a large scale. This technique had the added advantage that it was about 60 times more efficient in terms of budwood usage than the conventional technique.

This entire project has resulted in close co-operation between the Citrus and Subtropical Fruit Research Institute and commercial nurseries which are now producing sufficient trees on *Phytophthora* resistant clonal rootstocks to satisfy the entire demand of South Africa's avocado industry.

BANANA

PHYSIOLOGY

SS.2484/03/1/1: THE USE OF THE MERISTEM CULTURE TECHNIQUE FOR BANANA PROPAGATION. 1980-1983

J.P. Bower and C. Fraser

Williams bananas are thought to be infected with a number of systemic pathogens, which may possibly be eliminated by means of tissue culture. While methods do exist for the culturing of adventitious buds, it is felt that small shoot tips (meristem plus a few leaf primordia) could be more suited to pathogen elimination. An efficient, simple culture medium was required, and the most suitable one tested contained MS 62 salts, NaH_2PO_4 (340 mg/ℓ), L-tyrosine (200 mg/ℓ), thiamine (0,4 mg/ℓ), sucrose (3 %), agar (0,8 %), activated charcoal (0,5 %), kinetin 5 mg/ℓ), IBA (2 mg/ℓ) and NAA (2 mg/ℓ). From visually non-contaminated explants, 92 % showed shoot growth and signs of rooting after four weeks, the majority of these being suitable for transplanting to a high humidity chamber after six weeks.

Sundry horticultural crops

HORTICULTURAL CROPS

PHYSIOLOGY

VV.24//1/03/1/1: GROWTH CYCLE AND CARBOHYDRATE AND NITROGEN RESERVES OF THE HORTICULTURAL CROP RED TEA. 1979-1984

P.J.C. Stassen

Die-back of rooibos tea plants on a large scale within a few years of planting and the low yield per hectare are crippling problems of the industry. The effects of period, intensity and frequency of harvesting, as well as the effects of fertilising and irrigation on production and survival were studied on the Citrusdal Experiment Farm.

Application of lime, potassium and phosphorus had no effect on production and survival of rooibos tea plants. Soils on which the experiments were conducted, therefore, seemed suitable for the cultivation of rooibos tea without any additional applications of lime and other elements.

Harvesting during March produced the highest average annual production over five harvesting seasons. The effect of period and frequency of harvest is illustrated by the finding that the average annual production after five seasons was 45 % higher when plants were harvested during March only, compared to bi-monthly harvesting and 30 % higher than a single harvest during November.

The best survival results were obtained by harvesting monthly or bi-monthly, but the yield was lower. After five seasons more than 60 % of the bushes was still growing in the monthly or bi-monthly harvested plots compared to 40 % survival in a March and 35 % in a November harvest plot.

It is therefore recommended to harvest during March to ensure the highest possible yield. Harvesting twice per season, during November and again during March, may however be a feasable alternative, especially in areas where die-back is a serious problem.

Cutting at a height of 450 mm seemed to produce a higher average yield per year. These differences were however not yet significant after three harvesting seasons. Two to three irrigations per year produced an increased yield of more than 30 % compared with no irrigation, after only two seasons of differential irrigation.

PLANT PROTECTION RESEARCH

Entomology/Zoology

INSECTS

TAXONOMY

PB.2511/01/1/4: TAXONOMY OF COCCOIDEA IN SOUTHERN AFRICA. 1964-1981

G. de Lotto

When this facet was first registered in 1964, it consisted of three research components, the taxonomy of mealybugs (Pseudococcidae) by G. de Lotto; armoured scales (Diaspididae) by J. Munting and later by Y. Ben-Dov, and soft scales (Coccidae) by G. de Lotto. The overall aim of the facet was to survey the scale insects (Coccoidea) of southern Africa and to describe and illustrate new and old species, with particular emphasis on those attacking cultivated plants. From 1964 until 1981, when this facet was terminated, a large amount of material was collected and identified and a large number of scientific papers were published.

From 1964 to January 1971, work on armoured scales was carried out by J. Munting. During this time all the armoured scale insects described by C.K. Brain were remounted and lectotypes and paralectotypes designated. A substantial collection of identified South African and exotic armoured scale and lac insects comprising 7 500 permanent microscope slides representing 189 genera and 589 species was built up. A total of 110 species were described and figured, of which 70 were new, eleven new genera were erected and a large number of scientific articles were published.

Munting resigned in 1971 and in January 1972 Y. Ben-Dov was appointed to continue this work.

Many scale insects are important pests of agricultural crops in South Africa. From 1964 to 1979 a large collection of scale insects of southern Africa was established and considerable progress was made in their identification as indicated by the large number of scientific papers published during this period.

INSECTS

POLLINATION

PB.2511/29/1/1: THE ROLE OF INSECT POLLINATION IN SEED PRODUCTION BY CERTAIN CROPS IN THE OUDTSHOORN DISTRICT. 1972-1983

R.H. Watmough

The *Megachile* sp. found on the Oudtshoorn Experiment Farm to be colonising cut reed stems placed in two sheds adjacent to a lucerne land is evidently a good potential pollinator of lucerne. Seventy-one per cent of the pollen collected by this bee to stock its larval cells was lucerne. The next most commonly collected pollen was from *Acacia* sp. which constituted 23 % of the total.

It was not possible, however, to breed this *Megachile* sp. in large enough numbers to measure its performance as a pollinator of lucerne by direct observation of bees working on lucerne and corresponding seed set because mortality in the larval stages of the bee was so high (62%). The largest single cause of mortality was the chalcid, *Mellitobia* sp. (35%) and the next two greatest mortality factors were a meloid beetle (11%) and unknown causes (10%). The presence of these parasites would probably make the use of leafcutter bees (*Megachile* sp.) to pollinate lucerne in the Oudtshoorn district uneconomic because of the work involved in constantly trying to exclude them. Any foreign *Megachile* sp. introduced from overseas because of its presumed superiority as a lucerne pollinator would probably be ineffective because of the same problem.

INSECTS

POLLINATION

PB.2511/29/1/2: BIO-ECOLOGY OF CARPENTER BEES WITH SPECIAL REFERENCE TO THEIR ROLE AS POLLINATORS IN SOUTH AFRICA. 1972-1984

R.H. Watmough

In southern Africa there are about 30 species of the genus *Xylocopa* Latreille. Field data suggest a mean multiplication rate of x 2,64 per generation in natural *Xylocopa* populations - males being ignored in the calculation. As the only possible long-term situation allows each laying female to be replaced by one laying female in the next generation, an average of 62% of the females produced must die without laying eggs.

This situation has been found in other solitary Hymenoptera such as mud wasps (Freeman, 1981). Freeman gives figures ranging from only one in five to one in two emerging females of three species of mud wasps surviving to nest, multiplication rates being, as with *Xylocopa*, persistently above x 1,00 per generation. The loss occurs during reproductive migration, almost all female wasps emigrating from their birth place.

Of those wasps that do nest, some do so in sub-optimal regions where populations cannot sustain themselves. These sub-optimal regions act as a "sink" (Freeman, 1981). The migration and loss of the mud wasps occurs without any competition for nest sites which are not in short supply.

Xylocopa seems to show a similar situation as is shown by high emigration of prereproductive females from experimental shed populations, even with plenty of unused nesting wood. The action of parasites and invertebrate and vertebrare predators does not prevent this phenomenon as they only crop excess production in *Xylocopa* populations.

Thirteen percent of the pollen collected in 1982 and 1983 by *Xylocopa caffra* L. to stock its larval cells on the Oudtshoorn Experiment Farm, Rooiheuwel, was found to be from lucerne, *Medicago sativa*. The low usage of lucerne pollen combined with the fact that *X. caffra* was never seen visiting lucerne in any significant numbers, suggests that this bee is not very useful for lucerne pollination. It would appear that honey-bees are still the most economically viable pollinators of lucerne in South Africa.

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NEMATODES

TAXONOMY

PB.2512/01/1/2: PLANT-PARASITIC NEMATODES ATTACKING PLANTS IN SOUTHERN AFRICA. 1979-1984

D.P. Keetch

During the past 40 years, plant-parasitic nematodes have received increasing attention from agriculturalists in southern Africa. A check-list of plant and parasitic nematode associations was compiled from available literature and personal communications from nematologists in the region.

NEMATODES

PESTS

PB.2512/20/1/2: TREATMENT OF ESTABLISHED VINEYARDS WITH NEMATOCIDES. 1972-1983

P.C. Smith

A series of field trials were carried out in different viticultural areas of South Africa to determine the efficacy of various nematocides, applied in established vineyards. The chemical which received most attention was DBCP (1,2-dibromo-3-chloropropane), but fenamiphos and oxamyl were included in one or more trials. Various methods of application and dosage rates were used. DBCP consistently gave the best results. Statistically, significant control of *Tylenchulus semipenetrans* for more than three years was achieved with a single spring application of 58 kg DBCP/ha, while significant control of *Meloidogyne incognita, Macroposthonia xenoplax* and various *Xiphinema* spp. was also obtained for periods of up to two years. Time and method of application did not appear to play an important role in the final results.

Control of nematode populations in vineyards depended upon the species involved. Where a good degree of control was obtained, improved plant growth and fruit yield increased progressively with succeeding years. Along the Lower Orange River yield increases from treated vines of up to 30% were recorded.

For all practical purposes the use of DBCP has ceased since its withdrawal from use in the United States of America. Post-plant non-fumigant nematocides such as fenamiphos and oxamyl were tested on vines in South Africa, but with disappointing results. More research with these and other newly developed nematocides is needed for the effective control of plant-parasitic nematodes attacking grapevines in the Republic of South Africa.

NEMATODES

PESTS

PB.2512/20/2/1: THE TRANSMISSION OF GRAPEVINE VIRUS DISEASES BY NEMATODES. 1975-1983

P.C. Smith

The ability of the plant-parasitic nematode *Xiphinema index* to transmit grapevine fanleaf virus (GFV) to rooted grapevines under South African conditions was investigated. Root samples taken from virus-free vines planted in sterilised potting mixture and inoculated with 50 hand-picked viruliferous *X. index* gave a positive enzyme-linked immunosorbent assay (ELISA) reaction for the presence of GFV, four months after inoculation.

Inconsistent results were obtained by culturing *X. index* on rooted grapevines in the glasshouse and, therefore, fig was tested as an alternative host plant. It was found that only hardwood fig cuttings at least one year old would root successfully. Rooting of green fig cutting was unsatisfactory. Fig proved to be a better host plant for the culture of *X. index* than grapevines.

Attempts were made to determine the presence of GFV particles within *X. index*. Suspensions of

viruliferous nematodes were ground in a pestle and mortar or in a ball mill with carborundum powder to liberate the virus particles, but without success. However, disrupting the nematode body with ultrasonic sound, the use of a tissue grinder or the freezing of viruliferous *X. index* in liquid N_2 and then allowing them to thaw out (repeated twice) produced positive results. The freezing/thawing method appeared to be slightly superior to ultrasonic sound.

Suspensions of hand-picked *X. index* cultured on fig (a non-host for GFV), tested negative with ELISA while *Macroposthonia xenoplax* and *Xiphinema elongatum* (both of which are not known to be virus vectors) feeding on GFV-infected vines, tested positive. This technique can, therefore, be used to determine whether a nematode has fed on a GFV-infected plant but not whether it is a vector of GFV.

STORED GRAIN

PESTS

PB.2518/20/1/3: INSECTICIDE RESISTANCE IN *TRIBOLIUM* SPECIES. 1976-1984

J.H. Viljoen

Tribolium castaneum populations from more than 90 localities were tested for their resistance against mercaptothion and lindane, and for cross-resistance against ten potential grain protectants.

Resistance against mercaptothion and lindane was widespread and of a high degree. Some indications were found that lindane was still being used for the control of grain storage pests, despite the insecticide having been withdrawn from use for a number of years.

Most populations of *T. castaneum* tested were slightly cross-resistant to nine of the ten potential grain protectants, with a 1 to 5% survival rate when exposed to a discriminating dose. Only three populations showed slight cross-resistance to dichloorvos which appears to be the most promising chemical to be developed for practical application.

The low-level but widespread occurrence of cross-resistance against chlorpirifos-methyl and pirimiphos-methyl which have come into commercial use since these tests were started, will probably result in the rapid development of a high degree of resistance in *T. castaneum* to the two insecticides.

Plant pathology/Microbiology

BACTERIA

NITROGEN FIXATION

PB.2522/09/1/5: EVALUATION OF NITROGEN FIXATION BY GRASSES OF ESTABLISHED PASTURES. 1975-1983

J.L. Staphorst

This study was initiated after the grass *Azospirillum* association was reported in Brazil in 1975. The primary aim was to determine whether such associations occurred in South African soils and if so, with which grasses and the amount of nitrogen fixed, with a view to agricultural exploitation.

Azospirillum was consistently isolated from the roots of the following important pasture grasses from diverse localities in the Republic of South Africa: *Cynodon dactylon, C. nlemfuensis, Digitaria smutsii, Paspalum notatum* and *Pennisetum clandestinum*. Soils with a pH below 5,0 and low organic matter content seldom contained *Azospirillum*-'infected' roots. Isolations of *Azospirillum* could only be made infrequently from seven other important pasture grasses, while it was never found associated with the roots of *Anthephora pubescens, Cenchrus ciliarus* and *Eragrostis curvula*. However, isolates were obtained and characterised from a number of grain crops and sugar cane (Staphorst & Strijdom, 1978a).

The practice of pre-incubating the washed roots prior to the acetylene reduction assay as advocated by the Brazilians was found to cause a 50- to 100-fold increase in the *Azospirillum* population of the roots with a corresponding increase in acetylene reduction rates, with resultant optimistic estimations of the amount of nitrogen fixed (Staphorst & Strijdom, 1978b).

Pre-incubation was eliminated and as acetylene reduction assays were done with minimally disturbed

soil-root cores of field-grown grasses and nodulated legumes as controls. Only a low level of acetylene-reducing activity was found in the grass-root soil cores. The linearity of this reduction, compared to the time-limited activity of the nodulated legume suggested a very loose coupling between *Azospirillum* nitrogenase activity and the grass metabolism (Staphorst & Strijdom, 1982).

A number of inoculation experiments were performed under greenhouse conditions in Leonard jars. Local *Azospirillum* isolates as well as the Brazilian type culture inoculated on a number of wheat cultivars, sorghum, maize and *Pennisetum clandestinum*. Contradictory results were obtained.

Indications of growth stimulation, but in certain cases yield losses caused by inoculation were found with both local and Brazilian strains. The results did show that the local wheat cultivar Koalisie was easily 'infected' with local *Azospirillum* isolate M33/9. This isolate was originally obtained from maize roots and found to be a very active *in vitro* acetylene reducer.

In a later experiment a small yield improvement of the wheat cultivar Koalisie was obtained by inoculation with isolate M33/9 (Staphorst & Strijdom, 1978b). This result could not be repeated and further inoculation experiments in Leonard jars showed a measurable yield loss caused by M33/9 on Koalisie wheat when grown in the presence of nitrate nitrogen. This deleterious effect is ascribed to the denitrifying property of *Azospirillum*.

Artificially induced mutants defective in nitrate and nitrite reductase as well as nitrogenase were obtained from isolate M33/9. The mutants and wild type strain were used in a final inoculation experiment with Koalisie wheat in Leonard jars with and without nitrate nitrogen. The results obtained prove that *Azospirillum* does not fix measurable amounts of plant-available nitrogen but may exert a negative influence on the nitrogen balance by the denitrification of nitrate nitrogen.

The advantages of *Azospirillum* inoculations of crops under field conditions as is sometimes reported must be ascribed to stimulation of root development rather than nitrogen fixation.

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BACTERIA

NITROGEN FIXATION

PB.2522/09/1/6: ESTABLISHMENT OF NITROGEN-FIXING BACTERIA IN SOIL. 1981-1983

H. Jansen van Rensburg and B.W. Strijdom

This study was undertaken to determine if the level of nitrogen-fixing ability of an inoculant strain established in a soil for a number of years, will change over the period.

About 700 isolates of rhizobia from nodules of plants inoculated 4-6 years ago (average) were obtained from eight different farms and sites. During the period none of the fields were reinoculated.

Of the 700 isolates, 56 % were identified by serological methods as strains from five different inoculants used at the time of planting.

Identifiable and unidentifiable isolates were assessed for their abilities to fix nitrogen. These abilities were compared with the abilities of the homologous strain cultures from the culture collection in freeze-dried and natural states.

Results showed that inoculated strains reisolated from the nodules after an average of 4-6 years in the soil had the same nitrogen-fixing ability as the strains from the culture collection. Variation in ability occurred within the groups, but that was due to the normal distribution pattern which occurs within a population and can be disregarded.

Inoculation raised the level of effectivity of the soil rhizobial population from an average of 79 % to 94,6 % of that of the reference strains from the culture collection, which can be regarded as a significant improvement in nitrogen-fixing potential in the soil.

BACTERIA

NITROGEN FIXATION

PB.2522/09/1/7: EFFECTS OF PESTICIDES ON NITROGEN-FIXING BACTERIA. 1982-1983

H. Jansen van Rensburg and B.W. Strijdom

Thirteen herbicides and one nematocide were tested to determine their effects on survival of rhizobia directly in contact with these pesticides, and on nodulation of legumes when these pesticides are applied as pre-emergent treatments during planting of the legumes.

The two pesticides, Igran (a herbicide) and Telone II (a nematocide), used on peas by the Langeberg Co-operation, had no detrimental effects on rhizobia directly in contact with them, or on nodulation of plants after treatment, provided that the dosages as prescribed were strictly adhered to, especially in the case of Telone II. Use of Telone II at the normal dosages would necessitate a waiting period of at least two weeks (as prescribed) after treatment, but the use of the proposed microdosages proved harmless to the bacteria.

Brominal, Dyanap, Trif 480, Dual and Lasso caused an immediate decline in contact with the herbicides. Rhizobial strains seemed to differ in their ability to survive contact with the herbicides. Forty-two hours' contact proved the triazine group (Atrazine and Igran) to be harmless to all the strains of rhizobia included in the test, while a few other strains, mostly of the slow-growing group, survived contact with Basagran, 2,4-D-amine and KOP 3. The survival rates in these cases were low, however.

The pH of the solutions played no part in the survival of strains directly in contact with the pesticides.

Treatment of planted seeds inoculated with rhizobia showed that in Leonard pots (sand) very few of the treatments caused significant lowering of nodule numbers or nodule mass. It can therefore be expected that detrimental effects of herbicide treatments will be even less in soil where the protective action of the soils is more pronounced. This was borne out by soil-pot experiments.

The herbicides used in these experiments can therefore be used with a fair amount of confidence provided manufacturers' instructions are adhered to and it might be expected that the legume will be more influenced by the herbicides than the rhizobia.

PASTURE CROPS

PATHOLOGY

PB.2526/19/1/1: A SURVEY OF THE DISEASES OF THE PASTURE CROP LUCERNE. 1978-1984

A.H. Thompson and G.C.A. van der Westhuizen

Seven areas from the major lucerne production areas in the country were surveyed for fungal diseases over an 18-month period from December 1977 to May 1979. Sixty fields were sampled for leaf and stem diseases, 41 fields for root diseases, and six fields for crown diseases. Leaf and stem diseases were widespread in all the sampling areas with leaf diseases more serious than stem diseases.

Nine leaf pathogens were recorded, *viz Cercospora medicaginis, Leptosphaerulina trifolii, Leptotrochila medicaginis, Peronospora trifoliorum, Phoma medicaginis, Pseudopeziza trifolii, Stemphylium vesicarium, Urohendersonia platensis* and *Uromyces striatus*. The incidence of leaf diseases varied from 48,3 %-91,0 %, while disease severity values ranged from 0,6-1,8 (on a 0-3 scale). The average field sampled had an incidence of 69,6 % and a severity rating of 1,2 for all leaf diseases. Five stem pathogens were recorded, *viz Cercospora medicaginis, Colletotrichum destructivum, C. trifolii, Phoma medicaginis* and *Uromyces striatus*. The incidence of stem diseases varied from 3,5-62,3 %, while disease severity values ranged from $<$ 0,1-1,1.

The average field sampled had an incidence of 37,4 % and a severity rating of 0,4 for all stem diseases. The most important leaf pathogens encountered during the survey were *Leptosphaerulina trifolii* and *Phoma medicaginis* with disease severity ratings (SL's per leaflet) of 1,39 and 1,31, respectively. The second most important group comprised *Peronospora trifoliorum* (0,60), *Uromyces striatus* (0,52), *Stemphylium vesicarium* (0,50) and *Pseudopeziza trifolii* (0,49). The least severe leaf pathogens were *Urohendersonia platensis* (0,11), *Leptotrochila medicaginis* (0,08) and *Cercospora medicaginis* (0,06). *Phoma medicaginis* was the most important stem pathogen with an incidence of 39,6 %, followed by *Colletotrichum destructivum* (5,2 %), *Uromyces striatus* (1,5 %), *Cercospora medicaginis* (1,2 %) and *Colletotrichum trifolii* (0,8 %). *P. medicaginis* was the most important leaf and stem pathogen encountered overall. Crown diseases were

VIRUSES

infrequently encountered with *Fusarium acuminatum, F. equiseti, F. oxysporum* and *F. solani* the most frequently isolated fungi from diseased crowns. Root diseases, although present in all the sampling areas, were less frequently encountered than leaf and stem diseases. Root disease symptoms similar to the fusarium root rot complex and rhizoctonia root canker were found in all the sampling areas, with *Fusarium solani* and *F. oxysporum* having the highest incidence of isolation from diseased roots (26,8 % and 22,4 %, respectively), followed by *Rhizoctonia solani*, (3,4 %) and *F. equiseti* (2,3 %). *F. solani* and *F. oxysporum* were also present in 'healthy' roots at fairly high levels of incidence (20,4 % and 21,3 %, respectively). Disease symptoms similar to Phytophthora root rot (PRR) were present in some of the sampling areas, with *P. drechsleri* isolated from roots showing typical PRR symptoms. *P. megasperma* and *P. citricola* were isolated from soil collected from lucerne fields, which was baited with lucerne seedlings. In most of the sampling areas, a number of different pathogens were associated with root rot (including *Corynebacterium insidiosum*). It is recommended that cultivars resistant to the diseases reported from this survey become generally available, as these diseases are known to cause significant yield reductions of lucerne worldwide.

PASTURE CROPS

PATHOLOGY

PB.2526/19/1/3: INFECTION AND DISEASE DEVELOPMENT OF *LEPTOSPHAERULINA* LEAF SPOT IN LUCERNE. 1980-1983

Sandra C. Lamprecht

The pathogenicity of 18 isolates of *Leptosphaerulina briosiana* was studied. Inoculation tests in the laboratory (detached leaf method) and glasshouse showed that all the isolates were pathogenic on *M. sativa* cv. SA Standard. Small black spots, often surrounded by chlorotic areas, developed on inoculated leaves. Isolates of the pathogen differed in pathogenicity. Infected leaves in the glasshouse often turned chlorotic and defoliation occurred.

Isolates were studied for their ability to sporulate on potato carrot agar (PCA) in total darkness and in alternating light (near ultraviolet light) and darkness (12 h light/12 h darkness). After 7 days all isolates sporulated under alternating light and darkness, but no ascospores were produced under total darkness, even after 30 days.

Symptoms, caused by *L. briosiana* on 14 accessories of *M. sativa* in an experimental plot at the Oudtshoorn Experiment Farm, were described. The fungus was associated with three symptom types: black spots with chlorotic halos (type 1); large lesions, 1-2 mm in diameter with tan centres and brown irregular margins (type 2); large lesions, 1-2 mm in diameter with tan centres and brown irregular margins, surrounded by necrotic tan areas (1-2 mm) (type 3). All the different symptoms were found on plants of *M. sativa* cv. SA Standard. Symptoms recorded on other *M. sativa* accessions were: type 1 on Rhizoma, Misa Sirsa, Sonora, Galilea, WL 501, Arnold Thomas 66J; type 2 on Rhizoma, Calver, Alfalfa N3-34, San Miguelito, Bankuti, Karoo 70, WL 501, Arnold Thomas 66J; type 3 on Rhizoma, Moapa, Washoe and Galilea.

Phytosanitary research and activities

VIRUSES

PATHOLOGY

PB.2531/19/2/5: VIRUS DISEASES OF *PHASEOLUS, CYAMOPSIS* AND *VICIA* SPECIES. 1980-1982

V.H. Whitlock

This study was undertaken to screen imported material passing through the Buffelspoort quarantine station for the presence of dangerous virus diseases not present in South Africa. At the same time local crops were to be surveyed for the presence of such diseases.

As no seed of these crops was imported during the period of duration of this project and lack of staff prevented field surveys from being undertaken, no work was done on this facet.

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It was suggested that studies of seed-borne virus diseases of these crops in South Africa be undertaken instead.

Weed research

WEEDS

BIOLOGICAL CONTROL

PB.2551/22/1/2: THE EVALUATION OF *DACTYLOPIUS AUSTRINUS* DE LOTTO AS A NATURAL INSECT ENEMY OF THE JOINTED CACTUS WEED, *OPUNTIA AURANTIACA* LINDLEY. 1979-1983

H.G. Zimmermann and D.E. Malan

The primary aim of the study was to evaluate the effectiveness of *Dactylopius austrinus* as a biological control agent against *Opuntia aurantiaca* in relation to the existing chemical control campaign.

D. austrinus, once it has conolonised jointed cactus, is a very effective natural enemy which kills most of the plants, reduces the vigour of survivors and inhibits regrowth from dislodged cladodes. It is particularly effective at high host plant densities. Without the presence of *D. austrinus* the jointed cactus problem would have been much worse.

The aggregated distribution of jointed cactus has a bearing on the efficiency of herbicide applications. The efficiency of spray teams increases as a function of plant aggregation and because the presence of *D. austrinus* is also positively associated with aggregation of the host plant, these current spraying operations thus selectively eliminate the cochineal populations to the detriment of biological control.

Because *D. austrinus* is hampered in its efficiency by the limited dispersal of its wind-blown female crawlers, its increase in evenly scattered post-spray infestations is low until these infestations have recovered again to a dense and aggregated state. Under favourable conditions and with the presence of an adequate cochineal inoculum, which can be introduced artificially, these cochineal populations may again reach epidemic levels after about 74 to 160 months. Under epidemic conditions very few plants escape insect attack but because of chemical spraying this seldom eventuates.

The key mortality factor of isolated cladodes and small plants is desiccation during the hot and dry summer periods. Mortality caused by *D. austrinus*, although always substantial, only becomes more important than desiccation during rare epidemic phases.

This study suggests that control of jointed cactus should be integrated by selectively applying chemical or biological control methods, whichever is more suited. It is further suggested that infested areas be delimited into biological control, integrated control and chemical control areas. Several factors, however, limit the implementation of such a control strategy at this stage. These factors include, *inter alia*, the high subsidy on herbicides for chemical control, the need for new natural insect enemies that would complement *D. austrinus* and thus increase the biotic pressure on *O. aurantiaca*, and the lack of sufficiently trained weed inspectors.

PESTICIDES

TECHNOLOGY

PB.2552/52/1/1: THE INFLUENCE OF ADJUVANTS ON THE EVAPORATION RATE OF SPRAY MIXTURES USED ON COTTON. 1981-1984

H.A. Abbott

The effect of molasses on some physico-chemical properties and sprayability of a carbaryl wettable powder (wp) and a triazophos emulsifiable concentrate (ec) was studied in the laboratory and the field. The time needed to wet the wp increased from 14,5 s with water alone to 37,3 s with 20% molasses. Suspensibility dropped from 94% in water to 71% in 10% molasses, then increased to 83% in 20% molasses. The emulsion stability of the ec decreased when up to 15% molasses was added, then showed a secondary increase with 20% molasses. When sprayed in the laboratory on bean leaves, the deposit obtained

with both formulations decreased as the percentage of molasses was increased.

In an aerial application field trial, 10 % molasses gave a smaller deposit of active ingredient than water alone, while 20 % molasses gave a greater deposit, for both formulations. Molasses had an adverse effect on some properties of the spray mixtures, which resulted in lower deposits when spraying was done at high humidity in the laboratory. This effect was offset when spraying was done at lower humidity in the field, because molasses improved the impaction of droplets by increasing their density and by preventing the complete evaporation of small droplets.

The addition of 20 % molasses to water did not reduce the rate of evaporation of water from spray droplets. The 20 % molasses droplets evaporated at the same rate as water droplets until circa 20 % of their volume was left. When sprayed under field conditions at 30 % RH the volume median diameter (VMD) of the 20 % molasses spray (132 μm) was larger than the VMD of the water spray (116 μm) and more droplets smaller than 19 μm were captured on magnesium oxide slides than with the water spray. The addition of molasses improved the impaction efficiency of droplets by increasing their density, and increased the minimum size to which a given droplet could evaporate.

PESTICIDES

TECHNOLOGY

PB.2552/52/1/2: THE EFFECT OF SIMULATED RAIN ON DEPOSITS OF SOME COTTON PESTICIDES. 1980-1984

E. Pick, L.P. van Dyk and R. de Beer

The work reported here was undertaken to determine which kinds of rainfall and which properties of a pesticide formulation affect rainfastness. Two types of experiments were done. First, a field of commercially grown cotton was sprayed with various pesticides and an overhead sprinkler used to simulate rainfall.

Since the overhead sprinkler system could not be finely adjusted, a second set of experiments was done with a more controllable garden sprinkler and potted cotton plants.

PESTICIDES

TECHNOLOGY

PB.2552/52/1/3: THE INFLUENCE OF RAIN ON THE PERSISTANCE OF PESTICIDES ON COTTON.

H.A. Abbott

The effect of simulated rain on pesticide deposits can be severe. Even 1 mm simulated rain within 1 h after application was sufficient to remove an appreciable part of the deposit of some pesticides. About 70 % of parathion wettable powder (wp) was removed. Other formulations were more rainfast, for example, 1 mm simulated rain removed only 4 % of the original deposit of a carbaryl-molasses soluble concentrate (sc). This difference is most probably due to the inherent characteristics of each formulation, such as the type of wetting agents used.

No generalisations are possible, and thus each pesticide formulation will have to be evaluated separately for rainfastness. Nevertheless, it was clear that between 2 and 5 mm rain, one hour after spraying, will remove about half of the original deposit.

Deposits that have aged become generally more rainfast. The pesticide formulations tested varied in the speed at which they became resistant to simulated rain. The cypermethrin emulsifiable concentrate (ec) formulation rapidly became rainfast whereas the parathion (wp) formulation showed no signs of increased rainfastness over 2,5 h unlike the parathion (ec) formulation. The speed of penetration of a formulation may be influenced by the nature of the active ingredient which may be lipophilic. The formulating agents added to the mixture may also increase the transport of the active ingredient into the plant tissue; the two formulations of parathion behaved differently with the ec formulation showing a rapid increase in rainfastness, whereas the wp formulation did not show any increase in rainfastness over 2,5 h.

Surprisingly, the intensity of rain (defined as volume per time unit) over the range tested did not affect the rainfastness of parathion ec and wp. It was expected that rain of higher intensity would remove more of the deposits because the droplets would have greater impact. Perhaps rain of very low intensity, i.e. less than

20 mm h^{-1} would remove less of a deposit, but this type of rain seldom falls in the cotton-growing areas of South Africa.

Two products of parathion (ec), formulated by different companies, did not behave differently with respect to rainwashing. Wetting agents added to a parathion wp formulation did not seem to change the rainfastness from that of the original formulation.

These results illustrate the problems inherent in this type of experiment. Nobody outside an agrochemical company knows the exact composition of a formulation. This lack of knowlege makes results of experiments on rainfastness only applicable to the specific formulations tested. Even rigorous experiments to test the effect of a certain factor on rainfastness of a formulation may prove to be in vain because the manufacturer may decide to change the formulation at any time. This may then invalidate any conclusions drawn from the experiment with the previous formulation. This problem should not prevent us from recognising the tremendous effect rainfall may have on the eventual control of pests.

PESTICIDES

CHEMISTRY

PB.2552/53/1/01: DEVELOPMENT AND IMPROVEMENT OF ANALYTICAL METHODS OF THE PYRETHROIDS ON VARIOUS MATRICES. 1980-1984

P.R. de Beer

The pyrethroid group of pesticides is relatively new and its impact on the environment is not fully established. These pesticides are usually applied at very low levels of the active ingredient and an electron capture detector is needed to detect their presence. As the electron capture detector is not very specific, extensive cleanup of the sample extracts is needed before analysis.

As a result of inexperience in the residue analysis of this group of pesticides, published methods for their analysis were investigated. The investigation proved that cypermethrin can be analysed successfully and that with minor changes to the extraction method, multiresidues of cypermethrin, permethrin, decamethrin and fenvalerate can be detected at sub-nanogram levels.

As a result of a shortage of personnel and other priority considerations, the newer pyrethroids were not investigated and the facet was terminated.

ANIMAL PRODUCTION PROMOTION

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH

Animal production

DAIRY CATTLE

NUTRITION

VS.3112/05/1/1: THE USE OF UREA FOR HIGH-PRODUCING DAIRY COWS. 1979-1984

M.H. Neitz and H.P. de Bruin

Eighty-four high and moderate producing Friesland/Holstein cows were fed complete diets *ad libitum* with crude protein levels of:

Treatment 1 - 16 % (4-33 weeks *post partum*), positive control
Treatment 2 - 16 % (4-17 weeks), 12 % (1,4 % urea) (18-33 weeks)
Treatment 3 - 16 % (4-17 weeks), 12 % (18-33 weeks)
Treatment 4 - 12 % (1,4 % urea) (4-33 weeks), negative control

Milk yields for the high producers in Treatments 1, 2 and 3 were 26,7, 26,8 and 26,1 kg/day, respectively, differences being not significant. However, these cows produced significantly ($P < 0,01$) better than those in Treatment 4. Milk yield declined at a rate of 1,8 % per week after reaching peak production for high producers fed in Treatments 1, 2 and 3 and 1,4 % for cows in Treatment 4. Milk production for moderate producers showed the same tendency towards dietary treatment than the results obtained with the high producers.

High-producing cows on the 16 % crude protein diets had a significantly ($P < 0,05$) higher feed consumption between 4 and 17 weeks *post partum* than cows on the 12 % crude protein (1,4 % urea) diet. During the 18-33 week period dry matter intake differences were not significant irrespective of dietary treatment.

Results indicate that 1,4 % urea can be included in complete diets for high-producing cows from the 18th week *post partum* with great economic advantages.

DAIRY CATTLE

NUTRITION

VS.3112/05/1/2: THE EFFECT OF ROUGHAGE CHARACTERISTICS FROM *ERAGROSTIS CURVULA* HAY AND SUNFLOWER HUSKS ON MILK PRODUCTION AND MILK COMPOSITION FROM FIRST-CALF FRIESLAND HEIFERS. 1980-1984

B. Ferreira, M.H. Neitz and H.P. de Bruin

The effect of different inclusion rates of *Eragrostis curvula* hay in complete diets on the milk production and milk composition from first-lactation heifers was investigated. Twelve first-calf heifers were subjected to a trial having an extra period Latin Square rotating changeover design. Three complete diets with varying roughage (R) to concentrate (C) ratios were fed, *viz* 40R:60C, 50R:50C and 60R:40C.

In a second study, a further 12 first-calf heifers were used to determine if the replacement of 10 % *E. curvula* hay by sunflower husks has any influence on milk production and milk composition. In both studies the crude protein level in the complete diets was 16 %. The energy content decreased while the fibre content increased as the roughage fraction increased. No significant changes in milk production and milk composition were found by varying the inclusion rate of roughage.

Replacement of 10 % *E. curvula* hay by sunflower husks lowered the metabolisable energy (ME) content of the diets with the result that the ME intake and milk production were slightly reduced. Inclusion

of 10 % sunflower husks had little effect on milk fat.

PIGS

NUTRITION

VS.3119/05/1/1: THE OPTIMUM INCLUSION LEVEL OF PROTEIN SOURCES IN PIG GROWTH DIETS. 1979-1984

E.H. Kemm

Two experiments were conducted to

(1) determine the optimal inclusion level of heated full-fat soybean meal in pig growth diets and
(2) to compare heated full-fat soybean meal with sunflower oil-cake meal as a protein source in the diet of the growing pig.

In the first trial diets containing three levels of heated full-fat soybean meal (15, 18 and 21 %) each supplemented at five lysine levels (0,70; 0,75; 0,80; 0,85 and 0,90 %), were fed to 60 porkers (30 gilts and 30 boars) in diets, formulated to contain 13,2 MJ of DE/kg air-dry feed.

Full-fat soybean meal (heated) was compared to sunflower oil-cake meal as dietary protein source in the second trial. The diets were compiled to contain 0,75 or 0,8 % lysine and 13,3 MJ DE/kg air-dry diet. Five diets were individually fed, at both lysine levels, to 12 pigs per diet on an *ad libitum* basis. The soybean meal: sunflower oil-cake meal ratios (on a protein supply basis) in the five diets were 100:0; 75:25; 50:50; 25:75 and 0:100.

In the first experiment it was found that although live mass gain increased and feed utilisation improved with an increase in dietary soybean level, the differences were small and statistically insignificant. An increase in lysine level above the basic level of 0,70 % had no beneficial effect on any of the performance traits measured. The inclusion of 15 % heated full-fat soybeans and 0,7 % lysine, when fed in a 13,2 MJ DE diet proved to be sufficient for porker production.

In the second experiment the respective mean daily live mass gains calculated for the live mass interval 30 to 85 kg were 670; 662; 718 and 699 g/day for the five treatments (statistically insignificant, $P > 0,05$). Feed utilisation, in kg feed/kg gain in live mass, calculated for the same live mass interval was 3,2; 3,2; 3,2; 3,0 and 3,1 for the five treatments (statistically insignificant, $P > 0,05$). It was therefore concluded that in diets with the same lysine and DE content it is possible to efficiently replace heated full-fat soybean meal with sunflower oil-cake meal as a dietary protein source.

Animal products

MILK

MICROBIOLOGY

VS.3123/08/1/3: COMPARISON OF TESTS FOR DETERMINING THE NUMBER OF TOTAL COLIFORMS AND FAECAL COLIFORMS IN MILK. 1983-1984

H. Lück

The total coliform count of milk and fermented milks plated in violet red bile agar overlaid with violet red bile agar was compared with a modified coliform count of the same samples plated in nutrient agar overlaid with double-strength violet red bile agar (correlation coefficient $r = 0,85$, 152 samples). As expected, the latter count was significantly larger (mean log count = 5,696/mℓ) than the former count (mean log count = 5,269/mℓ). Because the total coliform count is only an index of sanitation and not a measure of risk to health, the modified coliform count has no real advantage over the original coliform count.

The relationship between the most probable number of faecal coliforms (in brilliant green bile broth at 44 °C, followed by a further identification in tryptone water at 44 °C and the plate count of faecal coliforms in violet red bile agar at 44 °C was not very consistent ($r = 0,47$, 124 samples). Plating in violet red bile agar at 44 °C gave a significantly higher count (mean log count = 4,487/mℓ) than the most probable number test

including the indol formation (mean log count = 3,639/mℓ). At present the violet red bile agar count at 44 °C may not be used for official purposes but may well be used by quality control laboratories as an index of faecal contamination.

MILK

MICROBIOLOGY

VS.3123/08/1/4: EVALUATION OF THE MANUAL PLATE LOOP METHOD FOR DETERMINING THE TOTAL BACTERIAL COUNT OF REFRIGERATED MILK. 1983-1984

H. Lück

The correlation coefficient associated with the 3rd degree polynomial: standard plate count (SPC) *versus* plate loop count (PLC) at 20 °C was R = 0,95 (n = 206). Below 20 colonies per plate the PLC showed a large range of variation for a given SPC. Above 350 colonies per plate the PLC gave lower counts than the SPC. The mean log count of the plate loop test carried out on milk at 20 °C differed from that of the SPC by 0,070 log units. This difference was, however, not significant.

At a milk temperature of 5 °C (prior to testing) the PLC was significantly lower than the SPC over the whole range of bacterial counts. The variance of log PLC between duplicate analyses was $S_R^2 = 0{,}015$ and 0,019 for milk at 5 and 20 °C, respectively. The accuracy expressed as variance of difference between log SPC and log PLC was $S_A^2 = 0{,}062$ and 0,046 for milk at 5 and 20 °C, respectively.

The manual plate loop test carried out on milk at 20 °C is suitable and accurate enough for determining the bacteriological quality of milk in a quality payment scheme.

MILK

MICROBIOLOGY

VS.3123/08/1/6: MILK: STATISTICAL EVALUATION OF AUTOMATIC BACTERIAL COLONY COUNTERS. 1983-1984

H. Gavron

The colony counts obtained (a) manually by analysts and (b) by two different automatic colony counters on a variety of media and plate types, were compared. It was found that the counts from one of the automatic colony counters (ACC2 i.e. Biotran III) were consistently within 10 % of the corresponding manual count, irrespective of the selective medium used or the plate thickness. The other (ACC1 i.e. Biomatic 16 900) were within 10 % of the corresponding manual counts only with respect to counts made on surface count plates or 6 mℓ pour plates prepared with Standard Methods agar.

MILK

MICROBIOLOGY

VS.3123/08/1/7: TEMPERATURE AND BACTERIOLOGICAL QUALITY OF MILK SAMPLES AS INFLUENCED BY THE TIME DELAY BETWEEN SAMPLING AND TESTING. 1984

H. Lück

The change of temperature and mean log total bacterial count of milk samples during the time delay between sampling and testing at an ambient temperature of 25 °C, was investigated. During working hours the lid of the insulated container was opened every ½ h for 1 min.

When pre-frozen eutectic packs were used as cooling agent the temperature of the samples was kept below 5 °C for 20 to 24 h. After this time the temperature and the total bacterial count of the samples increased rapidly. When this method of cooling is used, testing should start within 20 h of sampling.

When ice was used as a cooling agent the temperature of the samples could be kept at 0 to 2 °C as long as unmelted ice was available. In spite of the low temperature the total bacterial count increased significantly after 48 h. Testing should, therefore, start within 30 to 36 h of sampling. Samples stored in a self-cooling container showed similar changes.

If the time delay between sampling and testing is 40 to 50 h the samples must be preserved (e.g. 0,8 % boric acid) in addition to cooling by means of eutectic packs, ice or a self-cooling unit. The temperature of preserved samples may rise to 20 to 25 °C for several hours without a marked change of the bacterial count.

MILK

MICROBIOLOGY

VS.3123/08/2/1: MILK: THE EFFICACY OF DETERGENTS/DISINFECTANTS. 1981-1983

H. Lück

Suspension tests (SABS and AOAC method) and surface tests (IDF tube test, stainless steel cylinder carrier test and aluminium plate carrier test) were used to determine the efficacy of detergents/disinfectants. The relationship between the results obtained by the different tests was not very consistent (r = non-significant to -0,59), indicating that different problems were involved in each test procedure, i.e. reduction of the bacterial count on surfaces or in suspension, in suspension with or without organic matter (milk), on surfaces with dry or wet soil or with different surface structure. Furthermore, the exposure time, the temperature of treatment or the test organisms were different. The repeatability of the individual tests was acceptable.

For the evaluation of detergent/disinfectants used locally for the sanitation of dairy equipment, the cylinder carrier test (using small standardised stainless steel cylinders, length: 10 mm, inner diameter: 6 mm, outer diameter: 8 mm) is recommended. Eight cylinders are soiled with a suspension of the test organisms (*Staph. aureus* and *Escherichia coli*) or *Staph. aureus* and *Pseudomonas aeruginosa* in skim milk (diluted 1:10 in standardised hard water) and treated with the disinfectant solution at 40 °C for 2,5; 5 and 10 min. Every cylinder is classified according to the number of surviving bacteria which it contains after treatment (0 bacteria = Class 1, 1-20 bacteria = Class 2, 21-200 bacteria = Class 3, more than 200 bacteria = Class 4). The mean class score is calculated and a product is called "effective" when the bacterial count/cylinder yields a mean class score of 1,0-2,0.

MILK

CHEMISTRY

VS.3123/53/1/2: GLUCOSE CONTENT OF MILK AS INFLUENCED BY THE STAGE OF LACTATION, MILK YIELD, ENERGY INTAKE AND SOMATIC CELL COUNT. 1982-1983

H. Lück

Some 400 milk samples from udder quarters of 12 Friesian cows taken over a period of 3 months were tested for glucose content and somatic cell count. The glucose content (15,0 ± 5,6 mg/100 m*l*), which varied considerably from cow to cow, increased significantly with increasing stage of lactation (9 out of 12 cows; r = 0,34 to 0,55) and increased, therefore, also with increasing age of cow (9 out of 11 cows; r =0,34 to 0,55), but the glucose content also decreased with increasing milk yield (6 out of 12 cows; r = -0,34 to -0,62). The energy intake had little influence. A small significant increase in the glucose content with increasing energy levels was found (for all cows r = 0,09). The relationship between glucose content and log leucocyte count was relatively weak (r = -0,21 for all samples).

DAIRY PRODUCTS

MICROBIOLOGY

VS.3124/08/3/2: DAIRY PRODUCTS: UNDESIRABLE BACTERIA IN CHEESE. 1981-1983

H. Lück

For the enumeration of coagulase-positive staphylococci in cheese the Most Probable Number test carried out in Giolitti and Cantoni enrichment broth, followed by an identification of typical colonies grown on Baird-Parker plates (at 37 °C for 36-48 h), gave the best results. Black, shiny colonies grown on Baird-Parker plates which were surrounded by a zone of clearing (with or without an opaque zone) were identified microscopically for coccal cells and for coagulase activity.

For routine purposes the microscopic examination and the plasma coagulase test for identifying coagulase-positive *Staph. aureus* were sufficient. Additional tests for DNase and catalase activity and anaerobic growth eliminated only 5 % of falsely identified *Staph. aureus* colonies.

The average number of coagulase-positive staphylococci found in 72 Gouda and Cheddar cheeses was 2-3/g which is too small to cause food poisoning hazards. A local standard of less than 10 coagulase-positive per gram of cheese at four weeks (absent in 0,1 g of cheese) was suggested.

DAIRY PRODUCTS

CHEMISTRY

VS.3124/53/1/3: DAIRY PRODUCTS: THE INFLUENCE OF PSYCHROTROPHIC ORGANISMS ON THE MANUFACTURE AND RIPENING OF CHEDDAR CHEESE. 1983

T.E.H. Downes

Psychrotrophic bacteria demonstrated both proteolytic and lipolytic activity in raw milk stored at 6,5 °C and cheese yield decreased as the psychrotrophic level of the raw milk increased on storage.

Cheese yield reduction correlated with both lipid and protein degradation.

Fat losses were observed from whey fat values and protein losses from increased non-protein nitrogen values in the whey. Cheese yield studies should therefore involve assays of protein and lipid on dry matter basis as well as psychrotrophic and lipolytic counts of the raw milk.

DAIRY PRODUCTS

CHEMISTRY

VS.3124/53/3/3: DAIRY PRODUCTS: THE NUTRITIONAL VALUE OF WHEY MILK AS REGARDS ITS PROTEIN AND ENERGY. 1981-1983

W.A. Odendaal

With our present population and economic growth, more dairy products will be needed in future to help ensure a healthy nutritional status of the populations of the Republic of South Africa. This especially applies to children.

Whey cannot be discarded any more, but mixed with whole milk in the proportion of 60 % whole milk, 40 % whey and 0,5 % skimmed milk powder, a nutritious, palatable and acceptable milk product can be provided for all population and age groups in the country.

Supporting animal research

ANIMALS

NUTRITION

VS.3133/05/1/1: FEED INTAKE IN THE NUTRITION OF FARM ANIMALS: RESTRICTION AND REALIMENTATION. 1978-1984

J.C. Greeff

The purpose of this experiment was to study the effect of varying degrees of feed restriction on growth rate efficiency of feed utilisation, feed intake and body composition of lambs during and after restriction was discontinued.

The 0,55 and 0,45 groups were prematurely put on *ad libitum* at 31 and 28 kg live mass, respectively as the *ad libitum* group reached 45 kg before the 0,55 and 0,45 groups reached 33 kg and was slaughtered. Half of the lambs of the 0,55 and 0,45 groups were slaughtered at 31 and 28 kg live mass, respectively.

Individual feed intakes and live masses were determined every week. Body composition was determined by means of direct chemical analysis for protein, fat, moisture and ash.

A possible seasonal effect occurred in the feed intake pattern of the *ad libitum* group at the end of the restriction phase at 33 kg live mass. As the lambs approached 33 kg live mass, their feed intake, efficiency of feed utilisation and growth rate declined. This occurred at about 12 January 1981. Thereafter feed intake, efficiency of feed utilisation and growth rate increased again.

The possible seasonal effect also had a significant influence on body composition. Protein and fat deposition were higher before 12 January 1981 than thereafter.

The 0,45 group became fatter than the other restricted groups to the effect that total gain consisted of 61 % fat. Possible explanations are discussed in view of available evidence in the literature.

During the realimentation phase there were progressive increases in feed intake, growth rate, protein and fat deposition and improvement in feed utilisation of the previously restricted treatments between *ad libitum* and 0,65. Previously more severely restricted groups progressively decreased feed intake, growth rate, protein and fat deposition and the efficiency of feed utilisation.

ANIMALS

NUTRITION

VS.3133/05/1/3: FEED INTAKE IN THE FEEDING OF FARM ANIMALS: GROWTH. 1980-1984

J.P. Campher

Bos indicus types very often respond differently to dietary influences than expected when the responses of *B. taurus* are the considered criteria. Most available evidence suggests that *B. indicus* handle roughages proportionally better than concentrates, at least at *ad libitum* intake. Less is known about responses at lower levels of intake which are important from the point of view of estimating energy requirements for growth.

This study addresses the question of Simmentaler (*B. taurus*) and Afrikaner (*B. indicus*) type steers using three dietary energy concentrations, each fed at three feeding levels.

Sixty-three Simmentaler and the same number of Afrikaner weaner-steers were randomly allocated in separate experiments to one of three dietary energy concentrations and to one of three feeding levels according to a factorial design. The dietary energy concentrations were, respectively, 80:20, 50:50 and 20:80 of a concentrate-roughage mixture supplied in pelleted form.

The pooled *in vivo* digestibilities of energy of these diets were, respectively, calculated to equal 13,8; 12,7 and 11,8 MJ/kg DM and the calculated metabolisabilities (q values) 0,65; 0,55 and 0,50. The three feeding levels were calculated to be between the respective maintenance and *ad libitum* levels of energy intake of the two breeds. Intake and live mass were recorded at five slaughter masses over the range of 220-550 kg in Simmentaler and 190-460 kg in Afrikaner.

It is shown that efficiency of ME utilisation for live mass gain is influenced by mass, breed, dietary energy concentration and feeding level in the following manner:

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- Heavier steers required more ME per unit of gain.
- Simmentaler required less ME per unit of gain than Afrikaner, except for q = 0,50 at heavier live masses, suggesting breed by mass by dietary energy concentration interaction.
- The efficiency of ME utilisation as affected by dietary energy concentration showed q = 0,65 > q = 0,55 > q = 0,50.
- The proportional difference in efficiency of ME utilisation between q values was very similar between live masses for Afrikaner, but differed between q = 0,50 and q = 0,55; q = 0,65 for Simmentaler.
- The proportional difference between breeds was smaller at the low feeding level and q value than at the high feeding level and q value in accordance to recent literature.

The data suggest that cattle which receive specific feeding levels for prolonged periods may show quite different responses than would be expected from published gain/requirement tables. Secondly, the data support the viewpoint that *B. indicus* does proportionally better on lower quality diets. It is proposed that *B. indicus* does not exploit better quality diets than *B. taurus*, because it has not been subjected to long-term selection for efficiency on such diets.

ANIMALS

NUTRITION

VS.3133/05/2/3: PROTEIN DEGRADATION IN THE NUTRITION OF RUMINANTS. 1981

P.B. Cronjé

Protein degradability of 13 South African ruminant feed protein sources was determined by the artificial fibre bag technique. Three sheep, fed a basal diet of lucerne hay *ad lib.*, were used. Estimates obtained by two methods of calculation were not in good agreement for all feeds studied. Assuming an arbitrary rate constant for passage of undegraded protein from the rumen of 0,05, the effective percentage nitrogen degradation for the various feedstuffs as calculated by the two methods was found to be as follows: sunflower oil-cake (85,83); groundnut oil-cake (93,93); cotton-seed oil-cake (59,61); lupin (89,89); soybean (92,92); maize (74,64); maize silage (88,84); lucerne hay (79,72); *Eragrostis curvula* hay (30,27); maize gluten feed (89,87); maize gluten meal (24,25); dried brewer's grains (sorghum) (49,38); fish meal (36,42). Protein solubility in NaOH gave no reliable indication of the rapidly soluble protein fraction as determined by the artificial fibre bag technique.

A colorimetric method of determining protein degradation, using a diazonium chromophore, was not suitable, owing to the large molecular size of the chromophore.

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NUTRITION

VS.3133/05/2/4: THE INFLUENCE OF STARCH TO NITROGEN RATIOS ON *IN SITU* PROTEIN DEGRADATION IN ANIMAL NUTRITION. 1983-1984

P.B. Cronjé

Nitrogen and dry matter *in situ* disappearance of a range of feedstuffs, as influenced by various combinations of concentrate to roughage in the basal diet, and simultaneous changes in ruminal ammonia concentration were investigated in order to facilitate elucidation and prediction of basal diet effects. Test feedstuffs were selected so as to represent extremes in terms of probable protein and carbohydrate categories likely to elicit basal diet responses.

Twenty seven ruminally cannulated sheep were allocated to nine treatments in a completely randomised block design with three periods. The nine treatments consisted of three concentrate to roughage ratios (75:25, 50:50, 25:75 ratios of *Eragrostis curvula* hay to maize), upon each of which three ruminal ammonia concentrations (7; 11,5; 14,6 mM) were imposed. A regression approach involving a pilot experiment was adopted in order to determine the amounts of urea necessary to obtain the required ammonia concentrations. Ruminal particulate matter flow rates were determined using a ^{51}Cr mordanting technique.

The effect of basal diet on *in situ* protein and dry matter degradation was studied by imposing three ruminal ammonia concentrations on each of three diets containing varying concentrate to roughage ratios.

There were no significant effects of ruminal ammonia treatment, although the ruminal ammonia levels imposed differed significantly. Both dry matter and nitrogen degradation rates of *Eragrostis curvula* hay were significantly depressed by increased concentrate inclusion in the basal diet.

Effective percentage degradation of *Eragrostis* dry matter and nitrogen differed by up to 36 % and 19 %, respectively, between the high roughage and high concentrate diets, depending on flow rate. A similar depressing effect (17 %) was found in the case of lucerne dry matter disappearance, but not for nitrogen. There were no dietary effects on degradation rate of maize, sunflower oil-cake or cotton seed oil-cake. Effective percentage N degradation for maize, sunflower oil-cake and cotton seed oil-cake was 66,7 %, 96,2 % and 92 %, respectively, at a measured flow rate of 0,039 h^{-1}. Results were validated by the achievement of similar effects when rumen fluid obtained from sheep which had been allocated to the nine dietary treatments, was used in *in vitro* digestibility determinations.

Two major factors were identified as being responsible for the basal diet effects observed. They are pH-mediated changes in cellulolytic and hemicellulolytic rumen bacterial populations, and the degree of association of nitrogenous components with fibrous components within a feedstuff.

It was concluded that the *in situ* technique for determining protein degradation was a suitable screening method for routine use, but that determinations should be carried out on diets similar to those in which the intended protein source is to be included, until further research has been conducted.

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NUTRITION

VS.3133/05/3/7: DIGESTIVE PHYSIOLOGY AND METABOLISM IN THE FEEDING OF FARM ANIMALS - COUNTING AMYLOLYTIC AND GLUCOLYTIC BACTERIA. 1976-1984

R.I. Mackie

The results show that counts of amylolytic and glucolytic bacteria by the direct specific method rising a short (20-22 h) incubation period at 39 °C were found to be much lower than those obtained indirectly from the total culturable count incubated for 7 days. Increasing the incubation period of the direct counts to 5 days increased the colony count up to 10 times. But overgrowth of small slow-growing glucolytic colonies by large fast-growing glucolytic colonies occurred, as did small zones of amylolysis, surrounding less active amylolytic colonies, become overwhelmed by the large zones of the more active colonies.

A stepwise adaptation was carried out on eight sheep through diets containing 10, 24, 44, 60 to a final diet containing 71 % maize meal and molasses. The numbers of protozoa in the rumen increased in proportion to the amount of readily fermentable carbohydrate fed, up to and including the 60 % grain and molasses diet, while the numbers of the total culturable bacteria remained essentially constant.

However, the proportions of amylolytic and lactate-utilising bacteria increased, and there was an orderly shift from acid-sensitive to more acid-tolerant species, particularly amongst the lactate-utilisers in response to the gradual decrease in the ruminal pH. Up to this stage the protozoa probably controlled the rate of fermentation by engulfing starch grains and bacteria and were thus able to maintain the pH of the rumen above 5,5. Lactic acid appeared only transiently and the peak values tended to diminish as adaptation progressed.

The types of cellulolytic bacteria did not change during the experiment. Despite their acid sensitivity, the number of cellulolytic bacteria per gram of ingesta was of the same order after 54 days on the 71 % grain and molasses diet (0,5-13,3 x 10^7) as on the initial high roughage diet (3,2-7,6 x 10^7).

ANIMALS

NUTRITION

VS.3133/05/3/8: DIGESTIVE PHYSIOLOGY AND METABOLISM ASPECTS IN FEEDING OF FARM ANIMALS: BACTERIA AND LACTIC ACID. 1976-1984

R.I. Mackie

The ruminal metabolism of lactic acid was investigated *in vivo* under normal feeding conditions in four sheep each adapted to one of the following diets: high concentrate, intermediate, high-roughage containing

65,43 or 10 % maize meal and molasses, respectively, or lucern hay. A continuous basal turnover of ruminal lactate (0,01-0,02 mmol/ℓ/min) was found which increased 10-40-fold immediately after feeding when production exceeded utilisation and lactate accumulated in the rumen.

This was followed by an increase in utilisation rate which removed the accumulated lactate. Both lactate and glucose turnover were related to the amount of readily fermentable carbohydrate in the diet. Approximately 8; 6,5; 5 and 2,5 % of the total VFA was formed through lactate on the high concentrate, intermediate, high roughage and lucerne hay diets, respectively.

Rumen microbial counts of total culturable, glucolytic, amylolytic and lactate-utilising bacteria, and of ciliate protozoa were also performed on the four sheep. Numbers of micro-organisms in all groups were highest on the high concentrate diet and lowest on the two roughage diets. The proportions of the predominant genera from the different metabolic groups of bacteria differed, although in most cases the same organisms were present in the rumen on all diets.

The succinate pathway was found to be quantitatively more important in the conversion of lactate to propionate in the rumen. Although the numbers of lactate-utilising bacteria increased as the amount of RFC in the diet increased their metabolic activity was actually lower. Reasons for this finding are discussed together with factors influencing the regulation of lactate production and utilisation in the rumen.

ANIMALS

NUTRITION

VS.3133/05/3/9: DETERMINATION OF EXTRACELLULAR FLUID AND PLASMA VOLUMES OF MERINO SHEEP BEFORE AND AFTER A GLUCOSE TOLERANCE TEST. 1976-1984

J.G. van der Walt

A straight-line relationship between the fat content of Merino sheep and the difference between extracellular fluid (ECF) and glucose space was demonstrated. No significant differences were found between ECF, with (16,68 ± 1,78 %) and without (16,8 ± 1,39 %) a glucose load, and glucose space (15,5 ± 1,64 %) in non-obese young adult sheep. However, increasing the degree of obesity gradually decreased the ECF + glucose load volume (13,78 ± 0,54 %) and glucose space (12,98 ± 1,01 %) in relation to the unloaded ECF volume. Maximum difference observed was -3,95 % of body mass at a fat content of 40 %.

The observed shift of water from the rumen to the blood plasma corresponded to the theoretical quantity calculated from the osmotic changes brought about by the injection of 1 g glucose/$kg^{0,75}$ (about 15 to 25 g/sheep). An average of about 10 % of the injected glucose load was lost into the urine when the threshold in the kidney was exceeded.

The normally close correspondence between the glucose space (that hypothetical fraction of the body mass that holds dissolved glucose at the same concentration as plasma) and ECF volume is disturbed by an excess of body fat.

ANIMALS

NUTRITION

VS.3133/05/3/11: DIGESTIVE PHYSIOLOGY AND METABOLISM IN THE FEEDING OF FARM ANIMALS: GLUCOSE UPTAKE. 1977-1984

J.G. van der Walt

Unidirectional rates of tissue glucose and lactate metabolism and interconversions were measured by continuously infusing each metabolite labelled with ^{14}C into a jugular vein, and sampling blood from the aorta, vena cava, portal vein and hepatic vein. Measurements of blood flow permitted calculation of metabolism by the portal-drained viscera, liver, hindquarters and peripheral tissues.

In fed sheep, production of glucose occurred mainly in the liver during both pregnancy and lactation (67-70 %) with the remainder produced by the portal-drained viscera (absorbed glucose), hindquarters, and presumably the kidneys. Over 80 % of the glucose was utilised by peripheral tissues with about 35 % attributable to that of the hindquarters. About three quarters of the lactate production during pregnancy occurred in peripheral tissues; during lactation this declined to only about one third, presumably due to the

absence of the placenta and fetus.

Also for lactate, about 70 % was utilised by the liver during pregnancy, although this shifted during lactation so that less was used by liver and more by the portal-drained viscera. As a consequence, about 80 % of the lactate, during pregnancy, originated from glucose chiefly in peripheral tissues, and about 12 % of the glucose originated from lactate, chiefly in liver. During lactation, however, these interconversions were reduced about one half.

Despite these interchanges of ^{14}C, whole-body turnover rates for glucose and lactate were under- or overestimated only by 3-10 % and 2-6 %, respectively. Further, a comparison of (U-^{14}C) with (6-^{3}H) glucose indicated only a 6 %- and 2 %-recyling rate during pregnancy and lactation, respectively. Lactate thus does not appear to be a major precursor of glucose in the ruminant since most of the hepatic uptake is used for oxidation, or for various other anabolic pathways.

ANIMALS

NUTRITION

VS.3133/05/5/1: INTAKE RELATED RUMEN CHARACTERISTICS IN SHEEP FED A HAY OR SILAGE DIET. 1981-1983

P.H. Henning

This study was conducted to determine the roll which flow and fermentation of food in the rumen plays in differences in intake between hay and silage made from the same crop.

Hay, untreated silage and formic acid-treated silage were prepared from lucerne (*Medicago sativa*) harvested during the early bloom stage. Fermentation quality of silage as depicted by pH, water soluble carbohydrate, volatile fatty acid, lactic acid and ammonia contents differed markedly between treated and untreated silage. The hay and silages were fed *ad lib.* to S.A. Mutton Merino wethers.

Voluntary organic matter (OM) intake was significantly higher for hay ($P < 0,01$) and formic acid treated silage ($P < 0,05$) as compared to untreated silage. There were no significant differences between feeds for any of the flow and fermentation characteristics, namely rumen OM content, combined rate constant for fermentation and outflow of fermentable OM from the rumen, and rate constant for outflow of unfermentable OM from the rumen. These results indicate that differences in intake between hay and silage made from the same crop do not result from differences in the physical handling thereof in the rumen.

Untreated silage was clearly of poorer fermentation quality than formic acid-treated silage. This points to the role played by fermentation quality of a silage in the voluntary intake thereof, and the improvement in fermentation quality which can be obtained by the addition of formic acid during ensiling.

ANIMALS

NUTRITION

VS.3133/05/6/3: DIETARY COMPONENTS IN FEEDS FOR ANIMAL FEEDING: ROUGHAGE CHARACTERISTICS IN FINISHING DIETS. 1981-1984

J.P. Campher

Previous work at this Institute (Campher, 1982) clearly indicated that different roughages had different optimum levels of inclusion into high concentrate (maize meal-based) diets. These optimum inclusion levels, determined for eleven different types of roughage, were considered to be at the concentrate:roughage ratio where digestible organic matter intake reached a maximum. It was also concluded from these studies that particle size of the roughage and apparent digestibility were the two major factors determining the level at which the roughage should be included. In view of the preceding the aims of this study were as follows:

(i) An *in vivo* study of roughage characteristics, in terms of rumen flow dynamics, of four different roughage sources; and

(ii) to ascertain whether the *in vivo* determined roughage characteristics could be linked to easily determinable physical characteristics in order to predict optimal inclusion levels of a wide range of roughages.

The four roughages studied were sunflower hulls, wheat straw (milled through 50 and 6 mm sieves,

respectively) and cotton seed hulls and were fed to eight ruminally cannulated steers (*ca.* 700 kg) which were used in each consecutive study. Inclusion levels varied with 3% intervals within the range of previously determined optimum inclusion levels. The steers were adapted to their respective diets during a 21-day period whereafter experimentation began. Each animal's rumen was emptied manually four times, each at a different stage during the day. The animals received roughage during a further five-week period before adaptation to the next set of diets began. All rumen flow parameters were recorded.

The large individual and diurnal variations in the data resulted in difficulties with the statistical analyses. The use of *ad libitum* feeding levels, especially with high concentrate diets, when studying rumen flow dynamics should be reconsidered. Even with frequent feeding (four times daily) the animals ate mainly in the morning (08 h 00-12 h 00) and early evening (18 h 00-24 h 00). Feed given at 24 h 00 was mostly ignored.

It is, however, possible to draw some conclusion from these studies. It was found that higher levels of roughage decreased the flow rate of organic matter from the rumen. This seemingly resulted in a more incomplete rumen fermentation, as seen in the lack of higher volatile fatty acid production rates in spite of longer organic matter (OM) retention times. It would seem that the roughage tend to displace the concentrate from the rumen and hence a shift in site of digestion might occur. This phenomenon will, however, have to be studied in more detail. Unfortunately, the large variations in rumen flow parameters made the quantification of the roughage characteristics impossible and further studies, probably at below *ad libitum* feeding levels, must be done.

Publications

CAMPHER, J.P., 1982. Quantification of the roughage characteristics of different roughage sources in high maize fattening diets. M.Sc. (Agric.) thesis, University of Pretoria, Pretoria.

CAMPHER, J.P., ROUX, C.Z. & MEISSNER, H.H., 1983. Influence of roughages on the rumen retention time of concentrate. *S. Afr. J. Anim. Sci.* 13 (1), 48.

VETERINARY RESEARCH

Pathological investigations

PATHOLOGICAL INVESTIGATIONS

ANATOMY

OP.3211/02/1/1: PATHOLOGICAL INVESTIGATIONS: HISTOLOGY OF THE INTESTINAL TRACT OF *SUS SCROFA DOMESTICUS*. 1980-1982

M.S. Myer

A systematic histological description of the porcine intestine is given, as seen through the light microscope, transmission electron microscope and scanning electron microscope. Special attention was paid to the supporting connective tissue, and the arrangement of the different muscle layers and nerve plexuses. The surface morphology of the inner lining of the small intestine and colon was examined with the scanning electron microscope.

Further investigation was directed to the cytology of some specific cell types, such as absorptive epithelial cells, goblet cells, intestinal endocrine (argentaffine) cells, Paneth cells and globule leucocytes.

The absorptive epithelial cells of embryonic, neonatal and mature pigs were examined, with a view to characterising their different development stages. It was found that the nuclear position of the enterocytes varies in the development of the pig, from a distal position in the embryonic pig, to a medial position in two-week-old neonates, and finally assuming a proximal position in the adult pig.

Paneth cells, traditionally believed to be absent in the porcine crypts of Lieberkühn, were demonstrated with the aid of two different histochemical stains. The cells were found to be grouped along the sides, in the lower half of the crypts.

Argentaffine cells were demonstrated with the aid of a silver stain, and occurred throughout the intestine. Ultrastructurally, two different types of granules were seen, namely those predominantly oval or irregular in shape, and those that were predominantly round.

PATHOLOGICAL INVESTIGATIONS

Globule leucocytes were demonstrated in the lamina propria of the jejunum, in association with the bases of the crypts, near Paneth cells. The position occupied by other free cell types, such as lymphocytes, plasma cells, occasional mast cells, neutrophils and eosinophils in the intestinal mucosa and submucosa, was discussed in view of their importance with regard to the immune reaction occurring in the intestine.

PATHOLOGICAL INVESTIGATIONS

PATHOLOGY

OP.3211/19/2/1: PATHOLOGICAL INVESTIGATIONS ON NEOPLASIA OF DOMESTIC ANIMALS: A STATISTICAL SURVEY. 1977-1983

S.S. Bastianello

It is apparent from this survey that either the skin or mesenchymal tissues accounted for the majority of neoplasms in domestic animals in the Republic of South Africa.

If "jaagsiekte" is excluded as a type of ovine tumour, squamous cell carcinomas were the most common neoplasms in cattle, sheep, goats and cats. It appears that the high South African sunlight intensity is primarily responsible for the high incidence of this tumour.

In Equidae, sarcoids which are believed to be viral induced, were the most common neoplasms. Although canine neoplasms covered an extremely wide range, the most frequently encountered neoplasm was the mastocytoma. More than half of the tumours reported in pigs were lymphosarcomas. "Jaagsiekte" is still the most prevalent tumour (65 % of the tumours reported) in sheep.

PATHOLOGICAL INVESTIGATIONS

PATHOLOGY

OP.3211/19/2/2: PATHOLOGICAL INVESTIGATIONS ON LUMPY SKIN DISEASE. 1978-1982

L. Prozesky and B.J.H. Barnard

Microscopic lesions in cattle infected with the virus of the Neethling form of lumpy skin disease, comprised a granulomatous reaction in the dermis and hypodermis which extended to the surrounding tissue. During the early stages of the lesions a vasculitis and lymphangitis with concomitant thrombosis and infarction resulted in necrosis and oedema. A hallmark of the acute to subacute stages of the lesions was the presence of intracytoplasmic eosinophilic inclusions in various cell types. The inclusions consisted of the viroplasm which was identified as aggregates of electron-dense, finely granular to fibrillar deposits in which membrane-enclosed virions and occasional groups of tubular structures were observed. Various cytopathogenic changes were observed in cells exhibiting viral proliferation. The morphogenesis of the virions is discussed in relation to the cytopathogenic changes.

Toxicological investigations

TOXIC SUBSTANCES

TOXICOLOGY

OP.3231/18/2/2: TOXIC SUBSTANCES: TREATMENT AND PREVENTION OF CARDIAC GLYCOSIDE INTOXICATION IN CATTLE AND SHEEP. 1979-1983

J.P. Joubert, R. Anitra Schultz and J.A. Strydom

Cardiac glycoside intoxication is regarded as one of the seven most important plant-poisoning syndromes of ruminants in southern Africa. Plants from the Liliaceae and Iridaceae are most frequently involved.

EXTERNAL PARASITES

An 80 % survival rate was achieved when sheep (n = 10) which had received a lethal dose of *Urginea sanguinea* (Transvaal slangkop, 2,5 g/kg), were treated orally with activated charcoal at 5 g/kg and potassium chloride at 1 g/kg body mass. Clinical examinations, ECG recordings and serum potassium levels were done to monitor signs of poisoning.

Three out of 4 sheep similarly survived a lethal dose (1,25 g/kg) of *Moraea polystachya* (blue tulp) with the same treatment. Six out of 6 steers survived a lethal dose of the same plant when treated only with activated charcoal at 5 g/kg.

The minimal effective dose of activated charcoal given to sheep intoxicated with a lethal dose of blue tulp 12 h after dosing was found to be 2 g/kg. Only activated charcoal (B.P.) was effective. Ordinary barbecue charcoal was not of therapeutic value.

An increase in the level of serum potassium served as an indicator of acute poisoning in only a third of the animals.

Pre-dosing newly-weaned calves with no previous exposure to *Homeria pallida* (Natal yellow tulp), with an infusion of this plant, charred material or a small dose of chopped plant material, had no preventative effect on subsequent exposure in a camp heavily infested with the poisonous plant. Equal numbers of animals in each of the treated groups and in the untreated control group subsequently developed *H. pallida* poisoning. By the 4th day the treated and untreated animals appeared to have adapted and were avoiding *H. pallida* while grazing.

Entomological investigations

EXTERNAL PARASITES

PESTS

OP.3261/20/1/1: EXTERNAL PARASITES: ECOLOGY AND BIOLOGY OF *BOOPHILUS DECOLORATUS*. 1976-1982

A.M. Spickett

Studies were undertaken on the duration of the oviposition and incubation periods of this tick species and on the subsequent survival of larvae under natural conditions. The object was to determine whether pasture spelling and/or strategic dipping would be practicable for effective control of this parasite. The duration of the oviposition, incubation and larval survival periods was found to be extremely temperature dependent. These periods were shorter when environmental temperatures were high and longer during the cooler months. In addition, a high initial temperature at the time when the females dropped, and laid eggs, had the effect of decreasing the incubation period. This resulted in the synchronous hatching of eggs laid at different times.

Oviposition occurred, but no eggs hatched during the winter months of June and July when temperatures were below 10 °C. However, eggs laid during August, when temperatures were also below 10 °C, were able to hatch owing to the higher temperatures experienced during the following spring and summer months. Eggs laid before the middle of March are able to hatch before the onset of winter, but eggs laid after mid-March do not hatch until October owing to the low winter temperatures. Over-wintering is therefore at the egg stage.

Larvae survived for periods between a minimum of 26 weeks (from December to June) and a maximum of 42 weeks (from April to February). The length of the larva survival period and the viability of surviving larvae preclude the use of the pasture spelling alone as a practical method of control. Counts of engorged female *Boophilus decoloratus* in the same experimental area revealed peaks of activity concomitant with periods favouring the synchronous hatch of egg batches (i.e. during periods of rising temperature). A scheme for strategic dipping is postulated, whereby peak larval populations (and the resulting adults) are dipped at three-weekly intervals from December to February. It is thought that this would lower the population of ticks that normally yield the pre-winter population sufficiently to give efficient control with minimal dipping.

Cumulative daily temperatures measured on site in a Stephenson screen were correlated with the pre-oviposition, oviposition, incubation and larval survival periods determined in this area at the same time. It was found that, because temperature has a strong influence on the different periods, the incubation and subsequent survival periods in an area can be predicted by correlating a daily cumulative temperature curve for this area with data for the different developmental periods obtained during the present experiments.

Virus investigations

VIRUSES

PATHOLOGY

OP.3271/19/2/4: VIRUSES: PATHOGENESIS OF AFRICAN HORSESICKNESS. 1973-1984
B.J. Erasmus and S.J. Newsholme

This work was conducted to establish the sites of replication of African horsesickness (AHS) virus in the horse and to attempt to explain the marked variation in symptomatology observed in infected horses.

It was found that virus replicates mainly in lung, spleen and lymph nodes and that no virus replication takes place in cardiac muscle, brain, spinal cord and bone marrow.

The effect of serial passage of either spleen or lung as source of virus was determined in horses. Each successive passage of spleen material was followed by a longer incubation period and a more protracted course of the disease. With the third serial passage infection was no longer fatal. In contrast, serial passage of lung material consistently produced peracute cases with marked pulmonary involvement. These results suggested that virus populations differing in virulence can be obtained by selective serial transfer of either lung or spleen.

AHS virus was observed to produce morphologically different plaques in Vero cell cultures. Representative small and large plaques were cloned by a serial passage in Vero cells and the pathogenicity of these clones were then determined by intravenous inoculation into susceptible horses. The large plaque variant produced no clinical reaction whereas the small plaque variant caused severe clinical reactions.

The results suggested that a field strain of AHS virus is composed of a mixed virus population with regard to tissue tropism. Some particles multiply selectively in endothelial cells lining pulmonary capillaries, whereas other particles selectively multiply in blood vessels of the head and neck or in lymphoid tissue. The relative ratio of the different particles will, therefore, determine the clinical course of the disease.

Gross, histological and ultrastructural findings are described in 6 natural cases and in 2 experimental cases of AHS. From the gross lesions the cases were divisible into 2 groups which represented the previously described pulmonary and mixed forms of the disease. Histologically, abundance of fibrin and inflammatory cells in oedematous lung suggests that the pulmonary lesion is an exudative pneumonia. Lymphoid depletion and necrosis in germinal centres were consistently present. Electron microscopy failed to demonstrate virus particles or virus-associated structures in the tissues. Ultrastructural evidence of vascular injury was not apparent in oedematous tissues. Possible mechanisms in the development of the lung oedema are considered and a comparison is made with oedema induced by alpha-naphthyl-thiourea. Lack of structural evidence of vascular injury revealed by this study, extends some hope for therapy in African horsesickness.

Poultry and fish diseases

POULTRY

PATHOLOGY

OP.3291/19/2/1: POULTRY: PRODUCTION OF A BACTERIN AGAINST *HAEMOPHILUS PARAGALLINARUM* INFECTION. 1972-1982
S.B. Buys

Pathogenic *Haemophilus* isolates from South Africa require only nicotine adenine dinucleotide as co-factor and are therefore *H. paragallinarum*. Of the three known serotypes only A and B have so far been isolated here.

In producing the bacterin, optimum yields of 0,2 to 0,4 % packed cells were regularly obtained when *H. paragallinarum* was grown in Casman broth supplemented with 10 % chicken serum in a fermentation tank. To obtain the optimum whole cell antigen with serotypes A and B, growth must be terminated at pH 6 and 5,8, respectively, by the addition of 0,25 % formalin.

Stable oil in water emulsions of the bacterin could be prepared with locally available components. The

stability of the emulsion was tested by exposing it to a temperature of 37 °C for 21 days as well as by at least one freeze/thaw cycle.

Intrasinus challenge of approximately 10 colony-forming units of *H. paragallinarum* per bird gave a true reflection of the disease pattern as found in field cases. Re-isolation of the organisms out of the sinuses of immunised *versus* control birds 14 days after challenge, gave a reasonable indication of immunity. The effect on egg production is, however, a much more sensitive barometer of immunity. Bacterins containing a minimum of 0,1 % packed cells per serotype gave the best protection against a drop in egg production.

The vaccine can be safely administered to birds at a dose of 0,5 mℓ between 10 and 16 weeks of age. Older birds should receive a dose of 1 mℓ. The vaccine is not able to entirely prevent the development of clinical symptoms but vaccinated birds developed less air sack infection and have a much faster recovery rate than controls. It affords a very good protection against a drop in total egg production, this being only 3,5 % or less in comparison to as much as 30 % in unvaccinated birds.

Protozoal investigations

PROTOZOA

PATHOLOGY

OP.32*11*/19/2/4: PROTOZOA: CROSS IMMUNITY BETWEEN *BABESIA BOVIS* AND *B. BIGEMINA*. 1979-1983

J.H. Schoeman and R. Bessenger

The indirect fluorescent antibody test was used to measure the antibody response of cattle for 8 weeks after infection with either *Babesia bigemina* or *Babesia bovis*, or a combination of both species. Serological cross reactions were observed between the 2 species, but these were most marked when *B. bigemina* antigen was used. In animals infected with both *Babesia* spp. the *B. bigemina* reaction appeared to suppress the *B. bovis* reaction.

PROTOZOA

PATHOLOGY

OP.32*11*/19/2/5: PROTOZOA: EPIDEMIOLOGY OF BOVINE BABESIOSIS. 1975-1983

A.J. de Vos, F.T. Potgieter and R. Every

Babesiosis is the cause of serious economic losses in South Africa and involves most areas with an annual rainfall of more than 400 mm. Both *Babesia bigemina* and *Babesia bovis* are present and both are considered to be important. The vectors, distribution and factors influencing enzootic stability of both species were studied. Except in some areas only marginally suitable for ticks, and where tick control alone may be adequate, control by immunisation is recommended. Short-term prevention can be achieved by chemoprophylaxis.

The effect of tick control on the infection rates of *Babesia bovis* and *Babesia bigemina* was studied for 6 geographical regions in South Africa. Under conditions of poor tick control the situation for *B. bovis* was one of apparent enzootic instability in the 2 regions where its presence was recorded. Under similar conditions the situation for *B. bigemina* was generally stable.

With good tick control *B. bovis* infection rates were reduced to very low levels, with minimal losses being recorded. In the case of *B. bigemina*, good tick control reduced the infection rates in cattle but increased the risk of outbreaks.

It is concluded that, unless regular dipping is necessary to limit damage done by ticks *per se*, control of ticks is not justified economically as a means of minimising the risks of babesiosis outbreaks in South Africa.

PROTOZOA

PATHOLOGY

OP.32/1/19/3/3: PROTOZOA: IMPROVEMENT OF THE INFECTIVITY OF ANAPLASMOSIS VACCINE. 1981

F.T. Potgieter and J.B. Bester

Heparinised whole blood, heavily parasitised with *Anaplasma marginale*, was collected from 3 splenectomised oxen. Buffered lactose peptone (BLP) was added in equal volumes as a stabiliser and the mixture lyophilised in 2 mℓ aliquots after rapid freezing. The dried material was reconstituted with 2 mℓ sterile water and inoculated without delay. The product remained infective for at least 6 months when stored in an ordinary household deep-freeze unit. If this technique can be applied successfully to anaplasmosis vaccine it could have far-reaching effects on the production, storage and use of this rather labile product.

AGRICULTURAL RESOURCE UTILISATION

RESOURCE RESEARCH

Primary resources

SOIL

SOIL SCIENCE

GB.5111/32/2/2: THE EFFECT OF CINNAMIC AND BENZOIC ACID DERIVATIVES WHICH MAY BE PRESENT IN SOILS ON THE ROOT DEVELOPMENT AND NUTRIENT UPTAKE OF SUMMER AND SMALL GRAIN CROPS. 1980-1984

A.J. van der Merwe

During 1979 plant and soil samples were taken for analysis with the purpose to investigate poor growth of wheat on Arcadia soils of the Springbok Flats. The plant analysis showed no differences in the nutrient status of good and poor wheat. The soil analysis, however, indicated a significantly higher NO_2^- and NO_3^- content in the saturation soil extracts of poor wheat production areas in comparison with good wheat production areas. This pointed to anaerobic conditions. Since it is a well-known fact that mono-culture cultivation with wheat, especially when the wheat straw is not being removed from the land, can result in the built-up of growth inhibitors such as cinnamic and benzoic acids and their derivatives, it was decided to investigate the possibility that nitrite, alone or in combination with cinnamic and benzoic acids, can inhibit growth of South African wheat cultivars.

It was found that although identified inhibitors in water extracts from wheat straw do not have a drastic effect on wheat seedlings in low concentrations, the inhibitory properties of some cinnamic and benzoic acids can be increased considerably in the presence of nitrites. This led to the hypothesis that aromatic nitroso or diazo compounds are formed, which in low concentrations can prove toxic to wheat seedlings. Nitrite up to a concentration of 60 mg NO_2^-/dm^3 in the nutrient solution did not inhibit the development of wheat seedlings. It was determined that wheat cultivars differ with respect to top root growth when allowed to germinate in the presence of cold water wheat straw extracts.

In order to test the hypothesis that aromatic nitroso or diazo compounds are formed, the fixation of NO_2^- by benzoic and cinnamic acids were investigated. It was established that benzoic and cinnamic acids such as 0-coumaric, syringic and vanillic acid can fix 6,3; 4,7 and 8,7 mg NO_2^-/50 mg acid, respectively. The amount of fixation is higher at low pH values than at high pH values. A mixture of nitrite with cold water wheat straw extracts almost without exception inhibited root growth of South African wheat cultivars. It was calculated that the concentration of reaction products of benzoic and cinnamic acid nitrite mixtures in soils can be high enough to be toxic. It is the intension, however, to confirm this by means of gaschromatography analysis as soon as a suitable qualitative technique is developed. This is receiving the necessary attention of another researcher in another facet under the same project.

Owing to a man power problem it was not possible to study the effect of these inhibitors on the growth of other crops. The influence of the inhibitors or nutrient uptake could for the same reason not be investigated.

SOIL

SOIL SCIENCE

GB.5111/32/4/2: THE STRUCTURAL STABILITY OF SOUTH AFRICAN SOILS. 1972-1983

J.L. Hutson

Several tests of soil stability were conducted on 3 000 soil samples submitted during the course of a land type survey of South Africa. Air-to-water permeability ratio (AWR) was used as an index of swelling

and dispersion, modulus of rupture (MR) as an index of crusting and hard-setting tendency, and suspension (SR) and dispersion (DR) ratios as erodibility indices. Atterberg limits and linear shrinkage were determined on selected samples.

AWR values were most sensitive in distinguishing swelling and dispersive soil materials as the test value depends on the degree of swelling or dispersion after wetting and is not influenced by the state of aggregation or packing of the soil. Three broad stability classes were indicated. Apedal, orthic, soft plinthic and E horizons are generally stable, although clay particles of some E horizons are probably mobile. Neocutanic, lithocutanic, red structured, G and melanic horizons are of variable stability, while pedocutanic, vertic, gleycutanic and prismacutanic horizons are unstable. Air-to-water permeability ratios could be a useful diagnostic aid in soil classification for both agricultural and engineering purposes.

SR, DR and MR values are subject to greater influence by aggregation, sample preparation and test procedure, but measure important aspects of soil stability. Development of optimum methods in relation to soil type and test objective is required as is the determination of criteria for evaluating SR and DR values. Atterberg limits and linear shrinkage reflect the combined effects of both texture and clay mineralogy and could be used more widely for characterising agricultural soils.

The data show the range of values found for each stability index within diagnostic horizons. Assessment of overall stability using combinations of stability index values is demonstrated. The data provide a framework against which individual measurements may be evaluated.

SOIL SCIENCE

W.5111/32/3/3: SOIL INVESTIGATIONS FOR ARTIFICIAL PASTURES UNDER IRRIGATION ON TYGERHOEK EXPERIMENT FARM IN THE WINTER RAINFALL CROPPING AREA. 1980-1983

D.J. Beukes and J.H. Moolman

Artificial pastures, consisting of legume/grass mixtures and kikuyu, have to be established under irrigation on the Tygerhoek Experiment Farm. Some 150 ha of so-called marginal soils, i.e. shallow duplex types (Valsrivier, Estcourt) which are easily waterlogged, as well as highly compacted soils of the Dundee and Oakleaf forms, have been set aside for this purpose. Some of these soils are in the process of salinisation.

The aim of this investigation was twofold, *viz* (1) to determine those soil physical properties which are a prerequisite to the irrigation of these soils, and (2) to analyse relevant soil chemical properties in order to ameliorate the conditions of soil compaction, low infiltration rate and salinisation.

Thirteen profile pits were dug and disturbed samples, as well as undisturbed soil cores, were taken at two depths, *viz* 150 mm and 300/450 mm. Soil bulk density was determined in the pits. Infiltration rates were determined adjacent to the pits with a double cylinder infiltrometer. Other soil physical analyses involved particle size, water retention of disturbed samples at -10, -33 and -1 520 kPa, water retentivity curves and hydraulic conductivity. Water-holding capacities were calculated from -10 kPa and -1 520 kPa retentivity data.

Soil chemical investigations consisted of leaching of artificially packed soil columns (20 mm high x 44 mm diameter) with irrigation water containing different amounts of gypsum. Concentrations of the latter were, respectively, 0, 1/8, 1/4, 1/2 and 1/1 degree of saturation of the water. Percolate volumes were measured at specific time intervals and hydraulic conductivities calculated.

Soil texture of the A horizon of the Valsrivier forms is sandy loam. High bulk densities (ρ_b) of 1,66 to 1,71 g cm^{-3} indicate soil compaction. Infiltration rates (I) vary from 26 to 177 mm/h. Water-holding capacities (WHC) are also variable and range from as low as 15 mm to 37 mm of water per 300 mm depth. Bad irrigation management will easily lead to waterlogging of these soils. Electrical conductivity (EC_e) of the A horizon is 274 mS m^{-1}, indicating excessive salts. Exchangeable sodium percentage (ESP) of the B horizon is 77. It is recommended to add 1,09 kg gypsum per m^3 irrigation water to improve infiltration rate and to leach salts. Irrigation amounts not exceeding 25 mm to 30 mm per application must be adhered to.

The Dundee soils are loams with high silt contents and are highly compacted (ρ_b = 1,71 to 1,80 cm^{-3}). Infiltration rates are low and vary between 17 and 33 mm/h. Water-holding capacities are satisfactory and range from 35 to 42 mm/300 mm depth. The soils contain excessive salts and have EC_e of 107 mS m^{-1} and ESP of 71. Leaching trials have shown that permeability can be improved by up to 500 % on these soils when gypsum is added to the irrigation water. It is recommended that 1,09 to 1,96 kg gypsum must be

thoroughly mixed per m^3 of water. Because of the magnitude of clay dispersion that was observed when these soils were irrigated with pure water from the Riviersonderend River, it is imperative that gypsum must be added to increase the electrolyte and calcium concentrations. The recommended irrigation amounts are 15 to 20 mm per application.

The Oakleaf soils have no obvious soil physical limitations. Bulk densities are between 0,94 and 1,53 g cm^{-3}, WHC is 40 mm water per 300 mm depth and I range from 49 to 956 mm/h. These soils are ideal for establishing artificial pastures under irrigation. Irrigation amounts of up to 50 mm per application are possible.

Soils of the Glenrosa form have sandy loam to loam textures with a stone content of 53 %. The observed high ρ_b of up to 1,82 g cm^{-3} is due to the latter phenomenon. Water-holding capacities are low, very variable, and range from 10 to 31 mm/300 mm depth. Owing to the high stone content, these soils release a major part of the available water with the slightest decrease in soil water pressure. Infiltration rates are very high (225 to 2 208 mm h^{-1}). In view of the foregoing it is obvious that bad irrigation scheduling will rapidly lead to waterlogging. Recommended irrigation applications must not exceed 15 to 25 mm of water.

It is concluded that the irrigation planner now has all relevant soil scientific information at his disposal to improve infiltration rate and properly irrigate the soils under investigation. Taking the water use characteristics of the pasture mixtures into consideration, the planner can compile irrigation scheduling programmes for the various soils.

WATER

WATER REQUIREMENTS

GB.5112/31/1/1: RESEARCH OF DESIGN AND MANAGEMENT FACTORS OF IRRIGATION SYSTEMS AND SUBSURFACE DRAINAGE SYSTEMS TO DECREASE OVER-IRRIGATION AND SALINISATION, AND TO IMPROVE SOIL WATER MANAGEMENT AND CROP YIELD. 1972-1983

A. Streutker

One aim of this facet was to investigate irrigation, crop yield and subsurface drainage in the Vaalharts irrigation area in order to establish guidelines for improving the design and management of border irrigation and of subsurface farm drainage systems. Another aim was to improve the efficiency of the use of irrigation water and to prevent salinisation of the irrigated soil.

The 30 000 ha Vaalharts Government Water Scheme is situated in a flat fine sandy area, 1 100 m above sea level, in a semi-arid region, with an average uniform slope of 0,7 %, an annual summer rainfall of between 254 mm and 660 mm, and an annual evaporation of about 2 600 mm from a Class A pan. The shallow ground-water table between 0,9 m and 1,5 m is favoured by farmers for the easy cultivation of spring wheat, but also dreaded for waterlogging, salinisation and crop failure during years of above average rainfall.

During the period 1972-1982 the following research was undertaken:

(i) The total irrigation water and salt supply to the North Canal area (25 000 ha) and to each farm was recorded, as well as the distribution losses of the irrigation water and the subsurface drainage water and salt discharge into the Harts River.
(ii) The varying depths of the ground-water table and salinisation of the soil were mapped in the North Canal area. Soil salinisation and crop yield were investigated on 34 farms. The leaching of salts was monitored on 15 farms.
(iii) The drain spacing and the performance of the subsurface drainage system were measured on five farms and compared with predictions of several international drain-spacing equations.
(iv) Irrigation management was evaluated several times during a season on 100 commercial borders on 15 farms. Improvements of border layout and management of stream flow and cut-off time and position on 20 experimental borders on 4 farms and the research station were investigated.

Water and salt balance of the whole area

The figures for the supply and discharge for the whole area were determined. The water demand by the farmers was about 75 000 000 m^3 for the winter period and about 85 000 000 m^3 for the summer period. About 20 % of the water demand was added as additional water to the original demand to cover canal

distribution losses of between 10 % and 15 %, and canal leakage losses of between 3 % and 9 %. Subsurface drain discharge between 5 % and 9 % of the total water supply (before artificial drainage in 1975) and between 12 % and 20 % (after 1975) was an extra loss of water from the area.

The average salt discharge in the subsurface drainage water after 1975 was 1,25 g salt/s delivered in 1 m^3 drainage water/s. This is a total salt discharge of about 39 420 t/a, while the salt load in the irrigation water was about 51 200 t/a.

Soil salinisation and crop yield

During the period 1974-1976 of above average rainfall the water table rose to between 0,3 m and 0,6 m from the surface. Simultaneously salt accumulation in the top soil of 3 000 ha caused very low yields of several crops. The correlation between salt accumulation and wheat yield was determined. The deviation of the experimental curves from the straight line of Maas & Hoffman (1977) is explained by the detrimental influence of a sodium absorption ratio > 4, a high bulk density of the soil and a high moisture content of the soil on the emergence and growth of the young seedlings. The high bulk density could be the result of mechanised cultivation of the soil which has a fine fraction of 70 %, and the high moisture content probably results from the shallow water table.

Drainage and leaching of salt

Although subsurface drains were successful in leaching salts from recently salinised patches, about 1 500 ha of saline soil remained at the end of 1977 and about 300 ha were still salt-affected soils in 1980.

The average deviation of calculated spacings between two lateral subsurface drains and the existing drain spacings on farms was, for the Hooghoudt equation 5 %, the Bouwer/Van Schilfgaarde equation 8 %, the Van Schilfgaarde equation 11 % and for the Glover equation 24 %.

The efficiency of drainage systems with 90-100 m spacing was sufficient to cope with the average rainfall and irrigation water losses which resulted in a drain discharge of 1,6 mm/day. For rainfall on consecutive days totalling over 35 mm the drain discharge increased to 3,0 mm/day while the water table between the drains rose higher than 0,5 m above drain level at 1,5-1,6 m. A continuously high efficiency could be obtained with a spacing of about 66 m.

Flood irrigation on sandy soils

Commercial flood irrigation with a unit stream smaller than 7 $\ell s^{-2} m^{-1}$, a bad levelling of the seasonal border, a cut-off at the 90 % bed length position and outflow from the border into the ends of adjacent borders, caused over-irrigation on wheat and peanut borders and sometimes under-irrigation on wide row cotton and maize borders.

On experimental borders with a unit stream larger than 7 $\ell s^{-2} m^{-1}$, a well-levelled surface, a cut-off position of 60-65 % and no outflow at the end, a uniform distribution of water (Cu 90 % and Du 70-80 %) was found. It was possible to decrease the slope of the advance curve so that it was about parallel to the unchanging recession curve. However, the field application efficiency was sometimes over 100 %, indicating under-irrigation.

WATER

WATER REQUIREMENTS

GB.5112/31/1/2: DETERMINATION OF WATER-YIELD FUNCTIONS: A NORM FOR EFFICIENT USE OF IRRIGATION WATER. 1976-1983

A. Streutker

Because crops play an important role in food production and farmers are encouraged everywhere to enhance crop yield while making more efficient use of irrigation water, a previously envisaged practical aid to irrigation planning and management was again researched. This is the water-yield function (WYF) of a crop, or otherwise the ratio of crop yield to water usage.

Water-yield functions can be used by engineers to improve the seasonal allocation of water in the

irrigation canals, and by economists and irrigation planners to determine the most economic yield levels in relation to the cost and availability of water and the production costs. Furthermore, these water-yield functions can be used by the irrigation manager to distribute scarce water between different crops and to judge the efficiency of the water application of any irrigation system and irrigation management.

Water use and yield data for different wheat cultivars which were cultivated during the 1961-1978 period under irrigation and dry land at Vaalharts, Groblersdal, Springbok Flats and Pretoria, were used to deduce water-yield functions. The water-yield line was specifically drawn through points of highest yield with the lowest water use for several years and for which seedbed preparation, fertilisation, cultivar, seed quality, emergence and crop care were normal. The difference between the climates of the above areas caused evapotranspiration-grain yield lines to differ. However, the differences between the slopes of the transpiration-dry matter lines for irrigated wheat (method of De Wit, 1958) were so small that for practical purposes only one transpiration-dry mass line was found for different irrigated cultivars and different areas.

After compiling provisional water-yield functions of spring wheat, these were tested and extended with the latest data from South African literature, unpublished reports and from studies at farm level. The provisional WYFs for Pretoria, Loskop and Vaalharts were confirmed and WYFs were drawn for the new areas Sand-Vet and Glen.

The irrigation manager should be able to realise crop yield, which, for the quantity of water consumed, lies close to the WYF if the following guidelines are adhered to:

1. Between 37 mm and 75 mm of water should be applied by means of a conventional sprinkler or flood system, after evaporation of between 50 mm and 100 mm of water, respectively, from an evaporation pan; or
2. when the reading of a tensiometer at a depth of 0,3 m reaches about 70 kPa, a centre pivot system should move overhead immediately (sandy soils) or within 3 days (clay soils).

Water-yield functions of cotton, groundnuts, maize and lucerne were also derived using experimental data from South African literature, reports, unpublished material and results of irrigation studies at farm level. The WYFs were compiled for areas such as Upington, Olifants River (Cape), Middelburg (Cape), Ramah, Douglas, Vaalharts, Sand-Vet, Loskop and Pretoria.

The irrigation manager should be able to approach the WYF closely (i.e. usage) by scheduling irrigations when:

1. About 75 mm water is applied by means of conventional sprinkler or flood system after evaporation of between 100 mm and 200 mm water from an evaporation pan; or
2. between 24 mm and 30 mm water is applied by a centre pivot system during a summer season with rain or a winter season without rain.

WATER REQUIREMENTS

GB.5112/31/2/2: THE DETERMINATION OF WATER REQUIREMENTS OF CITRUS ORCHARDS IN THE EASTERN CAPE. 1968-1983

H.M. du Plessis

The aims of this facet were to design and build an economic weighing lysimeter system to accurately measure daily actual and potential evapotranspiration of citrus trees over a long term, to study their seasonal pattern of water use, to interpret findings in terms of irrigation, soil water and salinity regimes and plant physiological responses of trees to the environment, and to develop suitable alternative methods of determining evapotranspiration for use in practice.

A prototype weighing lysimeter with a mass of approximately 50 t, surface dimensions of 3,7 m x 3,7 m and depth of 1,8 m was built in 1970 and installed in a Valencia orange orchard at Addo in the Eastern Cape. The lysimeter contained a single transplanted tree from another part of the orchard. Performance was assessed over three years and found to be sufficiently promising to proceed with construction of two additional lysimeters and the overall refinement of the load-cell measuring system. The new lysimeters were completed in 1975. Typical calibration results indicate a resolution of 2 kg (2 ℓ) and an accuracy of 4 kg (4 ℓ). Over the 13,4 m^2 lysimeter area, this represents a resolution of 0,15 mm and an accuracy of 0,30 mm, respectively. Performance is highly satisfactory, considering that daily evapotranspiration varies between typical values of 30 ℓ during winter and 120 ℓ during late summer. Using repetitive measurement and

smoothing techniques, it has also been possible to obtain reasonable diurnal evapotranspiration curves on days of high water use.

As a step in the direction of establishing suitable relationships between evapotranspiration (ET) data and meteorological variables to be used for indirect ET assessment, the behaviour of the ratio of ET to Class A pan evaporation (E_O) was investigated. Even under optimal conditions of soil water content, the ratio was found to be subject to considerable daily and seasonal variation. Daily variation was found to be due to the decidedly low variance of daily evapotranspiration measurements in relation to that of corresponding pan evaporation measurements, implying the operation of a mechanism which enables the tree to regulate (tend to equalise) its water use from day to day, thus largely opposing the effects of fluctuations in evaporative demand. This regulatory mechanism is one explanation for fluctuating monthly values of ET/E_O. Short-term effects due to this mechanism, together with non-seasonal effects such as those brought about by fluctuating salinity levels, are clearly superimposed on seasonal trends associated with factors of a more seasonal nature. Such instability in the ET/E_O ratio makes it rather difficult to recommend as an irrigation scheduling index. Nevertheless, monthly mean values have been computed for use in the citrus areas of the Eastern and Western Cape, in the absence of more suitable indices. In the Sundays River Valley itself, the most appropriate index for irrigation scheduling is provided by continuing routine lysimeter measurements, especially in view of the conservative (i.e. stable) character of the ET values themselves.

The tree factor which couples ET (or more precisely, transpiration) to the atmosphere demand (either E_O or an appropriate combination of meteorological variables in a Penman-type expression) is the canopy diffusive conductance, i.e. the integrated leaf diffusive conductance C_L. Canopy conductance variations are therefore primarily responsible for short-term and seasonal fluctuations in ET-evaporative demand relationships. Intensive physiological measurements on similary treated trees in lysimeters and the surrounding orchard were carried out at intervals throughout two growing seasons (1977/78 and 1978/79) to throw more light on canopy conductance variations and also to explore the possibility of certain of the measurements giving rise to useful indirect methods of estimating transpiration. Besides direct transpiration measurements (using the lysimeters after covering soil surface with plastic sheeting), main measurements included leaf diffusive conductance C_L and leaf water potential. To be able to deduce water potential gradients, leaves in both uncovered states were sampled from various defined tree positions. Knowledge of transpiration rates and water potential gradients permitted hydraulic conductances to be calculated for various segments of the water flow pathway between soil and leaf, complementing direct measurements of leaf diffusive conductance.

Measured diurnal trends in C_L of trees in moist soils displayed a clear midday depression under high evaporative demand conditions, confirming the activity of a stomatal regulatory mechanism which responds to evaporative demand. The midday depression in C_L was enhanced by large soil water deficits, demonstrating that the regulatory mechanism responds also to a restriction in the water supply to the leaf. Under these conditions the soil-to-leaf hydraulic conductance and especially the soil-to-trunk segment also declined, suggesting that the restriction of the water supply to the leaves during the existence of large soil water deficits is not only due to the low soil water potential but also to a considerably reduced hydraulic conductance in the lower part of the soil-to-leaf pathway.

The interaction between hydraulic supply conductance and the canopy diffusive conductance appears to extend through to the seasonal scale. There is a similarity in seasonal trend with the diffusive conductance lagging behind the hydraulic conductance. The seasonal variation in soil-to-leaf hydraulic conductance is entirely consistent with suggestions in the literature that water uptake conductance by citrus roots is positively related to soil temperature.

The measurement of water potential gradient over a defined pathway in the tree appears sufficiently feasible to allow transpiration rate to be deduced, provided appropriate pathway conductances are also known or can be anticipated. The measurements of leaf diffusive conductance together with water vapour pressure deficits or leaf-to-air water vapour pressure gradients also appears promising as an alternative method of transpiration estimation.

The irrigation water quality fluctuated considerably during the course of the facet. From 1975 to 1979 the salinity of the water measured as electrical conductivity was generally higher than 200 mS/m, chloride concentration was in excess of 500 mg/ℓ and the sodium adsorption ratio was more than 8 $(\text{mmol}/\ell)^{0,5}$. The highest values recorded during this period were considerably higher. Irrigation with this water resulted in increased soil salinity, which reduced the availability of water to the trees. It was estimated that this caused a 25 % reduction in tree evapotranspiration during the summer of 1978/79 compared to the following year when a combination of heavy leaching by excessive rain and better quality irrigation water resulted in a drastic reduction in soil salinity.

The different irrigation frequency treatments were found to lead to the development of different *in situ* salinity profiles. Under high frequency irrigation the *in situ* salinity was higher than with the medium or low

frequency treatments. Also it showed little change, in salinity, with depth. Under low frequency irrigation small changes in salinity were found in the top soil but a marked increase was shown lower down. The salinity profile of the medium frequency treatment was in between. Lysimeter soils showed a higher *in situ* salinity than their free draining counterparts in the orchard as a result of the greater movement of water and salts to the surface under the wetter conditions prevailing in the lysimeters.

Because of inherent variability in yield of citrus trees, the lack of control of salinity levels and rainfall occurrences, and some uncertainty regarding the influence of variability of the rough lemon rootstocks used in the experiment, no meaningful attempt at establishing yield relationships could be undertaken. However, it may be concluded that the precise irrigation control in the orchard, made possible by lysimeter measurements, ensured a generally high level of yield, irrespective of the widely diverse irrigation treatments and in spite of salinity levels which caused considerable tree and yield losses throughout the Sundays River Valley between 1979 and 1980.

CLIMATE

METEOROLOGY

GB.5113/33/2/4: CLIMATE: PASTURE PRODUCTIVITY MODEL FOR THE KAROO. 1978-1983

J. Booysen

The objective of the research was to produce a model which uses climatic data to calculate productivity of natural veld. Various avenues of research were possible and many different approaches were open to investigate, but the following procedures were followed to reach the stated objective:

(a) The PUTU 11 model was investigated as to its efficacy in simulating plant water use and phytomass production and to improve it where possible.
(b) The Palmer model was investigated as to its dependability in reflecting growth conditions for climax grass.
(c) An independent variable was used to estimate annual phytomass production and the result was utilised to evaluate the performance of the PUTU 11 and Palmer models to reflect growth conditions for climax grass over a long time period.

Verifying the PUTU 11 model

The following steps were taken to verify this model:

(i) The triweekly phytomass production for the 1980/81 season at Glen was used to calibrate the PUTU 11 model and to improve its performance.
(ii) After this initial calibration the triweekly phytomass production of the 1978/79, 79/80 and 81/82 seasons at Glen was used to analyse the annual variation in production as to its dependability.
(iii) The water use of climax grass was tested by comparing weekly measured evapotranspiration with the simulated values.
(iv) The annual measured maximal phytomass production measured in four different research facets was compared with simulated values for the seasons 1963/64 to 1974/75.

The results showed that the improvements to the PUTU 11 model showed definite benefits and the model was considered to accurately simulate the annual march of phytomass production although there was a slight tendency for the model to overestimate production in below normal years. Water use was also simulated accurately. The degree of comparability of simulated and measured maximal production was not as successful, but this was ascribed to the difficulty in measuring production in the field.

Testing the Palmer model

(i) The Palmer indices were calculated using the meteorological data of Glen for the period 1930 to 1982 and the method described by Palmer (1964) and used by the USDA. A revised method was also used which is applicable when long-term meteorological data are not available and these indices were called the Palmeralt indices.

(ii) For want of an objective norm for drought intensity, the results were compared with the results obtained by Tyson & Dyer (1978) for the whole summer rainfall area.
(iii) To test the model's efficiency in describing growth conditions of climax grass it was compared to the measured maximal phytomass production.
(iv) Since an interesting relationship between seasonal rainfall and phytomass production was picked up during the research, the comparison was also made with total rainfall for the season October to March.

The results showed that as a drought index the Palmer index was better than the Palmeralt values. As far as simulation of production goes, the Palmeralt method is marginally better than the Palmer method, but summer rainfall shows a much higher correlation with production than both these indices.

Comparing PUTU 11 and Palmer models

A simple rainfall regression model was used as an independent variable to use as the comparison. The Palmer indices were converted to phytomass by using a regression equation. Values were calculated for the seasons 1929/30 to 1981/82 and compared.

The PUTU 11 is the superior of the models and although the rainfall regression gives satisfactory annual totals, the PUTU 11 model describes the various growth processes during the growing season, the growth stages and water use of natural veld. It is therefore more useful than a simple rainfall regression model.

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Surveys and demarcation

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/1: CLASSIFICATION OF VEGETATION IN THE CRADOCK EXTENSION WARD. 1979-1982

P.S. van Heerden, G. du Preez, M. Vorster and J.C. van Aardt

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Cradock.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Cradock covers a total area of 818 647 ha, consisting of 19 land types or portions of land types. Terrain unit 3 covers the greater part of the ward and hills ("bulte") are the most frequently found topographical unit.

The soil forms such as Mispah, Glenrosa and Swartland are relatively shallow (generally less than 300 mm deep).

The annual rainfall varies from 300 to 425 mm, the most important rainfall period being from February to April. Periodic droughts occur once every four years. Temperatures range from ± 42 °C to ± -7 °C and snowfalls occur regularly above the 1 600 m contour. Boreholes are the most important source of water for stock.

False Upper Karoo (No. 36) and False Karoid Broken Veld (No. 37) are the most important veld types (Acocks, 1975), with different variations of shrubland, grassland, dwarf shrubland, woodland and grass/dwarf shrubland as formation classes. The dominant plant species for a formation class follow a definite pattern on the different topographical units.

VELD SURVEYS

The condition of the veld rates as reasonable although injudicious grazing practices have caused deterioration of the veld in the past. The plant population density is either lower than ideal or the expected climax plants have been replaced by either sub-climax or dis-climax plants.

The present estimated grazing capacity of the veld is up to 41 % lower than the estimated potential grazing capacity.

The main farming enterprise is Merino sheep farming. The extension ward has an irrigation scheme in land types El, Sp and Tb.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/2: CLASSIFICATION OF VEGETATION IN THE GRAAFF-REINET EXTENSION WARD. 1979-1982

I. du T. van der Merwe, G. du Preez, M. Vorster and I.F. Slabbert

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Graaff-Reinet.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and descriptions of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Graaff-Reinet covers a total area of 16 470 km², consisting of 21 different land types or portions of land types. Terrain unit 3 occurs in 20 of these land types. A full range of all the topographical units are found in the extension ward. The aspect plays an important role on the mountain ranges where the northern slopes are warmer than the cold southern slopes, thus affecting the palatability of the vegetation on the different slopes.

The soil forms vary considerably according to the topographical units. The annual rainfall is 175 to 625 mm most of which falls in the Camdeboo and Coetzees Mountain ranges where the temperatures are considerably lower than on the plains (flats).

Karoid *Merxmuellera* Mountain Veld (Acocks, 1975) occurs on the mountains. The three variations of woodland are found on the topographical unit mountain slope and closed grassland covers 43 % of land type Sn.

The condition of the veld rates as reasonable, although the present grazing capacity is much lower than the potential grazing capacity. Cattle farming is an important additional farming enterprise, with irrigation lands being complementary to the farming set-up in the extension ward.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/3: CLASSIFICATION OF VEGETATION IN THE JANSENVILLE EXTENSION WARD. 1979-1982

I. du T. van der Merwe, G. du Preez, M. Vorster and I.F. Slabbert

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Jansenville.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and descriptions of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Jansenville extends over a total area of 8 284 km², consisting of 17 land types, all of which extend into adjoining extension wards. Unit 5 is the most commonly occurring terrain unit and unit 3 the most important one.

Watercourse is the most commonly found topographical unit whereas hills are the most important one, forming 35 % of a land type area. A variety of soil forms such as Mispah/Oakleaf and Glenrosa are found on a topographical unit mountain plateau.

VELD SURVEYS

Approximately 70 % of the total precipitation occurs in the form of heavy thundershowers. Droughts occur once every five years. No severe frost occurs and the extension ward has a long growing season. Irrigation water is available under the Beervlei Dam and along the Sundays River.

The veld types are Noorsveld, Succulent Mountain Scrub (spekboomveld), Karoid Broken Veld and Succulent Karoo (Acocks, 1975). Woodland is a main formation class in all land types. *Pentzia incana* is a dominant dwarf shrub on three land types, and co-dominant on 11 of the 17 land types. *Eriocephalus ericoides* is a sub-dominant dwarf shrub in the area. Dwarf shrubland is found on the plains (flats) of 11 land types.

The condition of the veld is reasonable on most of the land types yet the present grazing capacity is considerably lower than the potential. Extensive small stock farming is practised with Angora goats and Merino and Dorper sheep in a proportion of 50:30:20 %. Irrigation lands play a significant role along the Sundays and Groot Rivers.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/4: CLASSIFICATION OF VEGETATION IN THE SOMERSET EAST EXTENSION WARD. 1979-1982

I. du T. van der Merwe, G. du Preez, M. Vorster and J.C. van Aardt

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Somerset East.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and descriptions of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Somerset East extends over a total area of 593 000 ha, consisting of 16 land types or portions of land types. Terrain unit 3 covers 65,2 % of the ward, and 70 % or more of land types G, Ns, Vy (F2), Nb, Bb, Wi, Pm and Sn. Hills ("bulte") cover the largest area (31 % of the ward). The aspect influences formation classes and the occurrence of dominant plants on the steeper slopes of the more mountainous land types, Wi, Bb and Vy (F2).

Shallow Glenrosa and Swartland soil forms are found on the mountain slopes, hills and ridges. Oakleaf, Swartland and Valsrivier soil forms occur on the aprons and plains (flats), with steeper Oakleaf and Dundee on the flood plains and in the watercourses, and relatively shallow Mispah on the mountain plateau.

The annual rainfall varies from 210 to 875 mm. Land types Vy (F2), Bb, Et and Wi occur in the higher rainfall area and land types To, Pm, Pv and G in the low rainfall area. Forty-three per cent of the annual rainfall occurs during the period February to April. Periodic droughts occur once every five years. Temperatures range from approximately 42 °C to ± -7 °C. Snow falls regularly above the 1 600 m contour.

Thirteen different veld types (Acocks, 1975) are found and False Karoid Broken Veld covers the largest (35,2 %) area of the ward. Bush/thicket covers 5,9 % of the ward area.

Dominant trees in the woodland are *Acacia karroo, Pappea capensis* and *Euclea undulata*. On the lower lying mountain plateau of land type Et, *Themeda triandra* and *Paspalum dilatatum* become dominant, instead of *Merxmuellera disticha*.

The condition of the veld is reasonable, with an estimated grazing capacity of 60 % lower than the estimated potential grazing capacity. Incidental irrigation is practised on a small scale.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/5: CLASSIFICATION OF VEGETATION IN THE BURGERSDORP EXTENSION WARD. 1979-1982

W. van D. Botha, M.J. Roux, E.M. Meyer and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of

VELD SURVEYS

Burgersdorp.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Burgersdorp consists of 24 land types or portions of land types and all terrain units, except unit 2, occur in this ward. Land type Dr (Driefontein) consists of the full range of eight topographical units. The ward has soils of a more strengthened structure (Sterkspruit-Prismacutanic B horizon) on the flood plains.

The annual rainfall varies from 300 to 570 mm. Year round temperatures tend to be lower in the Stormberg area where snow occurs more frequently than in the rest of the ward. Boreholes are the main source of water for stock.

Land type Kl (Kapokkraal) consists of four veld types (Acocks, 1975). Woodland occurs in the Su (Suurveld) land type and is limited to the southern and western parts of the district of Steynsburg. The formation class open grassland dominates land types Bn (Botterfontein), Wp (Witkop), Le (Leliekrans), Kn (Knapdaar), Spl (Spookplaas) and Gu (Gumdale).

The shrub *Rhus erosa* (besembos) dominates the higher lying topographical units, and *Lycium* spp. (kriebos) the lower lying units. *Pentzia globosa* (vaalkaroo) is the most commonly occurring dwarf shrub in the area. Open grassland is the sole formation class on the mountain plateau of land types Le (Leliekrans) and Wp (Witkop).

The condition of the veld is reasonable. There is a possibility of improving the grazing capacity of between 0,4 and 2,0 ha/SSU (small stock unit) for all varieties of veld on all the land types.

Extensive Merino farming is the main farming enterprise while dairy farming contributes substantially towards farming income in the Stormberg area where drylands play a significant role. Irrigation lands represent less than 5% of the total area of the ward.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/6: CLASSIFICATION OF VEGETATION IN THE COLESBERG EXTENSION WARD. 1979-1982

C.A. du Toit, M. van Niekerk, E.M. Meyer and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Colesberg.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Colesberg consists of 11 land types, comprising a total area of 1 070 321 ha. Terrain unit 1/3 appears in all the land types and covers 36% of the total area of the ward. Land type Ag 13a occurs where plains (flats) comprise 76% of the total area of the land type. Two groups of soil are found on the hills, *viz* Mispah and Glenrosa (rocky soils on B horizon).

The precipitation varies from 275 to 400 mm annually; January to March being the most important rainfall period. Temperatures tend to be lower in the southern parts of the ward. Water for irrigation on a permanent basis is available to most of the riparian owners along the Orange River.

Land type Kv (Kikvors) is the only land type in which both the two occurring veld types, *viz* False Upper Karoo and Karoid *Merxmuellera* Mountain Veld (Acocks, 1975), are found.

Pentzia globosa (vaalkaroo) and *Eriocephalus ericoides* (kapokbos) are the most commonly occurring dwarf shrubs. *Eragrostis lehmaniana* (knietjiesgras) is the dominant grass but *Aristida diffusa* (beessteekgras) is most commonly found on the ridges. A formation class open grass/dwarf shrubland dominates five of the 10 land types where hills occur.

Shrubs regarded as invaders or undesirable plants lower the grazing value of the watercourses. There is, however, a possibility of doubling the grazing capacity of the ward.

Angora goats are kept in small proportions in the more mountainous, ridgy parts of the ward. Irrigation lands represent less than 3% of the total area of the ward and are mainly found among the Orange, Seekoei and Oorlogspoort Rivers.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/7: CLASSIFICATION OF VEGETATION IN THE DE AAR EXTENSION WARD. 1979-1982

C.A. du Toit, W.H. van Staden, E.M. Meyer and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of De Aar.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of De Aar consists of 19 land types or portions of land types. The extent of land types varies from 5 188 to 182 000 ha within the boundaries of the ward. The most commonly occurring terrain unit is unit 4. Plains (flats) are the most commonly found topographical unit and contribute an average of 33 % to the area of a land type. Mountain plateau and mountain slope are confined to specific areas.

Mispah is the predominant soil form. In the watercourses soils are much deeper and highly susceptible to erosion. The annual rainfall varies from 175 to 325 mm over the 19 land types. Snow occurs in the eastern parts of the ward. There is a limited supply of water for irrigation from rivers and earth dams in this ward.

The most important veld types (Acocks, 1953) are False Upper Karoo, Central Upper Karoo and False Arid Karoo. Closed woodland occurs only in the Fb 17e land type which is situated along the Orange River. *Prosopis juliflora* (mesquite tree) is dominant in certain western parts of the ward and becomes a threat in the watercourses and flood plains.

The present grazing capacity is much lower than the potential, but an improvement of between 0,7 and 1,9 ha/SSU (small stock unit) is possible for all varieties of veld on all land types.

Extensive Merino and Dorper farming are practised for the production of wool and mutton, respectively. Cattle farming is limited to a few dairy cattle for household purposes. Irrigation and drylands play an insignificant role in the total farming enterprise of this ward.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/8: CLASSIFICATION OF VEGETATION IN THE MIDDELBURG EXTENSION WARD. 1979-1982

M.J.A. Coetsee, M. Seyfferdt, E.M. Meyer and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Middelburg.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Middelburg consists of 20 land types which comprise an area of 1 476 700 ha. Land type Fr constitutes the largest portion (207 336 ha) of a land type within the boundaries of the ward. Terrain unit 2 is the only unit not to be found in any of the land types. Unit 4 is the most commonly occurring terrain unit, comprising 35,3 % of the total area of the ward.

The most commonly occurring topographical units are plains (flats), mountain slope and hills ("bulte"). The soil forms are generally shallow. Seven veld types (Acocks, 1975) occur in the ward, with definite signs that the veld type Karoid *Merxmuellera* Mountain Veld is expanding.

An inseparable mixture of grass/dwarf shrubland occurs on six land types. *Acacia karroo* is a dominant tree on the riverine areas of eight land types and an open stand of *Diospyros lycioides* is found on one watercourse. *Pentzia* spp., such as *P. incana, P. globosa* and *P. spinescens*, contribute 41,6 % towards the dwarf shrubs in the ward. Relatively unpalatable dominant trees, shrubs and dwarf shrubs occur. An

expanding area of the grass *Merxmuellera disticha* is also found in this ward.

The condition of the veld is reasonable, although less desirable plants occur on all land types and the present grazing capacity is much lower than the potential. It is possible, however, to increase the grazing capacity by between 0,4 and 2,4 ha/SSU (small stock unit) for all varieties of veld on all the land types.

The climate for all land types is homogeneous, i.e. cold winters followed by hot summers and characterised by notable differences between day and night temperatures. A north-westerly wind prevails which at all times has a desiccating effect. The rainfall is higher in the eastern than in the western parts, *viz* 375 mm in the east as against 280 mm in the west.

Extensive sheep farming for meat and wool production is the main farming enterprise. Intensive irrigation farming plays a significant role and the Upper Fish River Irrigation area receives water from the H.F. Verwoerd Dam.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/10: CLASSIFICATION OF VEGETATION IN THE CARNARVON EXTENSION WARD. 1979-1982

W. van D. Botha, G.Z.J. Barnard, M. Vorster and C.H. Erasmus

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Carnarvon.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Carnarvon consists of 21 land types or portions of land types, comprising a total area of 2 902 800 ha. The topography changes from pans to mountain plateau and the altitutde fluctuates from 860 to 1 660 m. The ward has an undulating landscape, and terrain unit 1/3 occurs most frequently and covers 56,5 % of the ward. The most commonly found topographical unit is undulating hills.

Glenrosa and Mispah soil forms occur on the hills, ridges and mountain slopes; and Hutton, Clovelly, Shortlands, Dundee, Sterkspruit, Valsrivier, Glenrosa and Mispah on the plain (flat), flood plain and watercourse. Considering factors such as rainfall, wind, temperature and the occurrence of droughts, the ward has a semi-desert climate.

Veld types No. 29 and 35 (Acocks, 1975) are the most commonly found, and No. 27 and 32 cover the area to a lesser extent. Approximately 97 % of the water needs is supplied by boreholes.

The following formation classes are the most prominent on the different topographical units: sparse shrubland on the undulating areas (23,5 %); open shrubland on the flats (18,4 %), the ridges (14,1 %) on the undulating areas (13,0 %) and the watercourses (7,0 %).

Sixty per cent of the veld condition is rated as reasonable, with a possibility for increasing the grazing capacity by approximately 30 % through the application of sound management. Extensive sheep farming with Dorper and Merinos as the most important breeds is the main farming enterprise.

Lands cover 1-2 % of the area and veld the remaining 98-99 % of the ward.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/11: CLASSIFICATION OF VEGETATION IN THE KENHARDT EXTENSION WARD. 1979-1982

N. Nortjé, G.Z.J. Barnard, M. Vorster and S.W.P. Theron

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Kenhardt.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation,

condition of veld, grazing capacity and farming pattern.

The Extension Ward of Kenhardt consists of 35 land types or portions of land types and covers an area of 3 729 297 ha. The topography mainly consists of undulating areas and ridges, varied by flats and watercourses. The altitude fluctuates between 540 and 1 220 m. Terrain unit 1/3 covers 79,7 % of the ward and hills are the most important topographical unit.

Soil forms are Hutton, Glenrosa and Mispah on the undulating regions, ridges, apron and plains (flats); and Valsrivier, Hutton, Dundee and Clovelly on the flood plains, watercourse and pans.

The annual rainfall ranges from 125 mm in the western parts to 180 mm in the eastern parts. Periodic dry spells occur twice every three years in the western and once every three years in the eastern parts. The annual maximum and minimum temperatures vary generally from -4 °C to 45 °C, with frost occurring from May to the beginning of October. Desiccating winds often occur.

Veld type No. 39 (Acocks, 1953) covers a small part of the ward. Approximately 97 % of the water needs is supplied by boreholes.

In some regions *Prosopis juliflora* is an invader plant.

The most important formation classes on the different topographical units are sparse shrubland on the undulating areas (50,9 %) and the ridges (6,1 %); and open shrubland on the undulating areas (10,8 %). At present the condition of 76 % of the veld is reasonable. The average grazing capacity is 6,8 ha/SSU (small stock unit) as compared with an average potential grazing capacity of 5,5 ha/SSU.

Dorpers and Karakul are the two most important breeds in the extensive sheep farming enterprise. Irrigation farming is practised to a limited extent on farms adjoining the Orange River.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/12: CLASSIFICATION OF VEGETATION IN THE PRIESKA EXTENSION WARD. 1979-1982

W. van D. Botha, C.H. Erasmus, G.Z.J. Barnard and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Prieska.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Prieska consists of 35 land types or portions of land types and covers an area of 2 178 826 ha. The topography changes from watercourses to mountain plateau, with terrain units 1/3 and 4 as the most frequently occurring units. Plains (flats) are the most general topographical unit of the ward. The altitude fluctuates between 750 and 1 450 m.

The dominant soil forms are Hutton, Mispah and Glenrosa on the plains (flats) and the undulating hills; Mispah on the ridges; and Dundee in the watercourses. The soil depth is 50 to 300 mm on the ridges, with an average depth of 100 mm.

The ward has a semi-desert climate, but is more moderate in the eastern part. Approximately 70 % of the rainfall occurs in the form of heavy thundershowers.

Orange River Broken Veld (No. 32) (Acocks, 1953) is the most important veld type. Open shrubland covers more or less 44,6 % of the area of the ward and in some regions *Prosopis juliflora* is an invader plant.

Fifty-six per cent of the condition of the veld rates as reasonable in relation to its potential. The present average grazing capacity is 5 ha/SSU (small stock unit) as compared with the potential of 3,8 ha/SSU. A small area of the ridges in the western part of the ward has a capacity of 20 ha/SSU. The grazing capacity could possibly increase by approximately 33 %.

Irrigation farming is practised on farms adjoining the Orange River. The different land types in the ward could possibly be combined into Reasonably Homogeneous Farming Areas.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/13: CLASSIFICATION OF VEGETATION IN THE BEAUFORT WEST EXTENSION WARD. 1979-1982

H.R. Becker, A.J. Wiid, C.F. Visser and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Beaufort West.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Beaufort West has 34 of the 43 land types which have been described, extending into adjoining extension wards. Terrain units 4 and 5 are found in 38 and 37 of the land types, respectively. Terrain unit 2 (5%) is found in land type Fa 62 (Baviaanskloof). Land type Ic 44 entirely consists of terrain unit 3. Land types Ag 29, Ag 33 and Ag 34 consist of the full range of topographical units, with watercourse as the most commonly occuring unit. The soil forms are shallow, except in the watercourses.

The annual rainfall varies from 120 to 350 mm. Little difference in temperatures between the land types is experienced. Snow occurs more frequently in the Nuweveld Mountain area than in the rest of the ward. Boreholes are the main source of water for stock.

Seven veld types (Acocks, 1975) are found. Woodland is confined to 36 land types, shrubland to all the land types, dwarf shrubland to 35 land types, grassland to ten, grass/dwarf shrubland to four and bush/thicket to one land type. *Pentzia* species are dominant on 24 of the 35 land types on which dwarf shrubs are found. Most shrubs in this ward can be regarded as invaders.

The condition of the veld rates as reasonable, but the present grazing capacity is considerably lower than the potential. It is possible, however, to improve the grazing capacity for virtually all the varieties of veld on all land types, especially in the watercourses where the grazing capacity can be improved by at least 50%.

Extensive Merino farming is the main farming enterprise although a significant number of Dorpers are also found. Angora goats are kept in the southern parts of the ward. Irrigation land is complementary to the farming set-up of the ward.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/14: CLASSIFICATION OF VEGETATION IN THE FRASERBURG EXTENSION WARD. 1979-1982

C.B. Reitz, I.J. van der Merwe, C.F. Visser and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Fraserburg.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Fraserburg consists of 20 land types or portions of land types, with units 1/3 and 4 as the most common terrain units. Land type Ag 29 consists of the full range of topographical units, yet land type Ib 96a-e, consists of one topographical unit only. The soils of the plains (flats) show a marked variety, i.e. Glenrosa, Dundee, Hutton, Mispah, Swartland and Oakleaf.

The annual rainfall varies from 60 to 350 mm over the 20 land types. The six most important veld types are Succulent Karoo, Western Mountain Karoo, Mountain Rhenosterbosveld, Arid Karoo and Desert False Grassveld, False Arid Karoo and Central Upper Karoo (Acocks, 1975). Woodland is confined to nine land types, Shrubland to 15 and Dwarf Shrubland to 19. Less desirable plants appear on all land types, but it is

possible to substitute these with more desirable plants through the implementation of sound grazing practices.

The main farming enterprises are Merino and Dorper farming with drylands playing a minor role in the Roggeveld Mountain area.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/15: CLASSIFICATION OF VEGETATION IN THE LAINGSBURG EXTENSION WARD. 1979-1982

C.B. Reitz, I.J. van der Merwe, C.F. Visser and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Laingsburg.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Laingsburg consists of 24 of the 29 land types extending into the adjoining wards, with terrain unit 4 occurring in all the land types. Soil forms vary according to the topographical units.

The annual rainfall varies from ± 125 to ± 300 mm, most of which falls during the period February to April. The precipitation during winter in the western parts of the ward is also significant. Summer and winter temperatures tend to be lower in the northern mountainous area.

There are six veld types (Acocks, 1975) in this ward. Woodland is confined to 26 land types, shrubland to 27, dwarf shrubland to 26 and grassland to one (Fb 63). *Merxmuellera* spp. (olifantsgras) are dominant in the Komsberg area. Watercourses are found in 27 of the 29 land types.

The condition of the veld rates as reasonable, with a present grazing capacity much lower than the potential. However, it is possible to increase the grazing capacity by at least 50 % (in the watercourses).

Extensive Merino farming is the main farming enterprise, yet a significant number of Dorpers are also found. Angora goats are kept in the southern parts of the ward. Cattle farming plays a minor role. Irrigation lands represent more or less 5 % of the total area and are complementary to the farming set-up in the ward. In certain localities in the southern parts of the ward fruit production is significant. Dryland farming is practised in the far western parts.

VELD SURVEYS

POTENTIAL STUDIES

K.5132/36/1/16: CLASSIFICATION OF VEGETATION IN THE VICTORIA WEST EXTENSION WARD. 1979-1982

H.R. Becker, D.J. Roux, C.F. Visser and M. Vorster

Owing to the importance of natural grazing in extensive farming areas, this study, based largely on vegetation and dominant plant species within each formation class, was conducted in the Extension Ward of Victoria West.

The work comprised four phases, *viz* preparation, veld surveys, processing of compiled data and description of land types in terms of location, extent, topography, soils, climate, water sources, vegetation, condition of veld, grazing capacity and farming pattern.

The Extension Ward of Victoria West consists of 17 of the 18 land types which have been described, extending into the adjoining extension wards. Unit 5 is the most commonly occurring terrain unit and unit 4 the most important one. The most common topographical unit is hills ("bulte").

Soil forms are Clovelly, Glenrosa, Swartland, Hutton and Rensburg on the mountain plateau; Glenrosa on the mountain slopes; Glenrosa and Mispah on the ridges and hills; Hutton and Shortlands on the aprons ("voorskote"); Glenrosa, Dundee, Hutton, Mispah, Shortlands, Valsrivier and Swartland on the plains (flats); Oakleaf, Dundee, Shortlands, Mispah and Valsrivier on the flood plains; and Dundee in the watercourses.

LARGE STOCK

The annual rainfall varies between 170 and 625 mm. Summer and winter temperatures tend to be lower in the Sneeuberg area. Boreholes are the most important source of water for stock,

Mainly seven veld types (Acocks, 1975) occur in the ward; *Rhus* spp., *Euryops* spp. and *Elytropappus rhinocerotis* are dominant in the higher lying topographical units. *Merxmuellera disticha* (suurpol) is dominant in the Sneeuberg area. Shrubs that can in the most cases be regarded as invaders or undesirable plants lower the grazing value of the watercourses.

The veld condition rates as reasonable, the present grazing capacity being much lower than the potential. It is possible, however, to improve the grazing capacity of all varieties of veld on all land types. The present grazing capacity varies from 2,09 to 10,0 ha/SSU (small stock unit) as compared with the potential capacity which fluctuates between 0,75 and 10,0 ha/SSU.

Extensive Merino farming is practised, yet a significant number of Dorpers are also found. Angora goats are kept in the southern parts of the ward. Irrigation lands, which represent less than 5 % of the total area of the ward, are complementary to the farming set-up.

RESOURCE UTILISATION RESEARCH (ANIMALS)

Summer rain cropping areas

LARGE STOCK

NUTRITION

H.5321/05/1/1: LARGE STOCK: CALF PRODUCTION FROM THE BEEF HERD BY MEANS OF OPTIMAL SUMMER UTILISATION OF FERTILISED VELD IN THE SUMMER RAIN CROPPING AREA. 1983-1984

J.W. Cilliers, L.M. Vermaak, A.C. du Preez, D. Oosthuysen and J.J. Jaarsma

The feeding value of unfertilised and fertilised natural summer veld for lactating cows, was evaluated over a period of five years on a *Cymbopogon-Themeda* veld type near Potchefstroom. The fertilisation rate was 100 kg N plus 10 kg P/ha/a.

Twenty cows with their calves grazed on each of the surfaces of unfertilised and fertilised veld, so that the grazing capacity of the fertilised veld was 100 % higher than that of the unfertilised veld.

The feeding value of the grazing was determined during different stages of the season by means of *inter alia* chemical analyses and *in vitro* digestibility of samples, which were collected with oesophageal fistulated cattle. Pasture intake by and growth performance of the animals were also measured. The composition of the unfertilised veld, in terms of representative grass species, was also determined. *Themeda triandra* was the only palatable species that was decreased by fertilisation, while *Eragrostis curvula* was the only relatively unacceptable species that increased on fertilised veld.

The higher intake of the fertilised-veld grazing by the cows, with a higher nutrient content and digestibility in comparison with that of the unfertilised veld, resulted in better individual growth performance by the cows and the calves on the fertilised veld.

At the fertilisation rate concerned in this study, it seems not only possible to produce more than 100 % more meat per hectare on fertilised summer veld in comparison with that per hectare unfertilised veld, but, depending on fertiliser and meat prices it may also be possible to produce more profitable from fertilised veld than from unfertilised veld.

LARGE STOCK

NUTRITION

H.5321/05/5/1: THE UTILISATION OF SHEEP FAECES TO RESTRICT CONCENTRATE INTAKE BY LACTATING DAIRY COWS. 1978-1981

W.C. Hugo, C.W. Cruywagen and T.P.N. Coetsee

The primary objective of this study was to determine to what extent sheep faeces could be included in

concentrate mixtures of lactating dairy cows, to restrict concentrate intake, and to serve as a source of recycled feedstuffs. The following two aspects were investigated:

1. The effect of concentrate mixtures containing different levels of sheep faeces on milk yield, milk composition, body mass changes, concentrate intake and concentrate: roughage intake ratios by lactating dairy cows (production trial).
2. To determine the influence of sheep faeces on the digestibility of the experimental rations (digestibility trial).

For the production trial forty-eight Friesland cows were randomly divided into eight comparable groups according to body mass, previous milk production and age, immediately after calving. One group received no sheep faeces and the seven remaining groups received different quantities of sheep faeces, ranging from 20 % to 50 % in their concentrate mixtures. Sixty-four Friesland steers were used to determine the digestibility of the different rations.

Total milk yield and total fat-corrected milk production did not differ significantly between treatments. The fat content of milk from cows receiving no sheep faeces was significantly lower ($P < 0,01$) than that of cows receiving sheep faeces in their concentrate mixtures, while the milk of cows receiving no sheep faeces had a significantly higher ($P < 0,01$) protein content than that of cows receiving sheep faeces.

The total body mass changes of cows receiving no sheep faeces were significantly higher ($P < 0,01$) than those of the rest of the treatments. Cows receiving no sheep faeces had a significantly higher intake of concentrate ($P < 0,01$) than cows receiving sheep faeces.

The restricting effect of sheep faeces on the intake of concentrate led to a higher income above feed costs for cows receiving sheep faeces in their rations, in comparison with cows receiving no sheep faeces.

Apparent digestibilities of dry matter, organic matter and crude protein of the ration without any sheep faeces, were significantly higher ($P < 0,01$) than that of the rations containing sheep faeces, while the apparent digestibility of crude fibre did not differ significantly between the experimental rations.

LARGE STOCK

NUTRITION

H.5321/05/7/1: LARGE STOCK: CONCENTRATE SUPPLEMENTATION FOR DAIRY BULL CALVES RECEIVING DIFFERENT RATIOS OF SOYBEAN FLOUR, WHEY POWDER AND COLOSTRUM UNTIL WEANING AGE. 1981-1984

C.W. Cruywagen

Five groups of seven Friesian bull calves received different combinations of soybean flour (S), whey powder (W) and preserved colostrum (C). On a dry matter basis, the experimental diets consisted of 20 % S, 60 % W and 20 % C (Treatment 1); 10 % S, 60 % W and 30 % C (Treatment 2); 20 % S, 40 % W and 40 % C (Treatment 3); 10 % S, 40 % W and 50 % C (Treatment 4) and whole milk as control (Treatment 5). The respective crude protein (CP) and metabolisable energy (ME) contents of the diets were 24,6 % and 15,1 MJ/kg (Treatment 1); 22,8 % and 16,4 MJ/kg (Treatment 2); 28,9 % and 17,5 MJ/kg (Treatment 3); 27,1 % and 18,8 MJ/kg (Treatment 4) and 26,8 % and 18,4 MJ/kg (Treatment 5).

A calf starter concentrate (20 % CP and 10,4 MJ ME/kg), consisting of 48,5 % maize meal, 30 % HPC-42, 20 % ground lucerne hay and 1,5 % salt was available *ad libitum* from four days of age. Calves received the (liquid) experimental diets at a rate of 12 g dry matter (DM)/kg birth mass, reconstituted to 15 % DM, and the control group received whole milk at a rate of 10 % of birth mass. All calves were weaned at 30 days of age. Body mass gain (kg) and starter concentrate intake (kg) for calves in Treatments 1 through 5 were 5,7 and 7,2; 6,1 and 6,2; 9,3 and 8,9; 8,7 and 10,8; 10,5 and 5,4, respectively. Total DM intake (kg) and feed efficiency ratio (kg DM intake/kg body mass gain) were 18,6 and 4,8; 18,7 and 3,6; 20,5 and 2,4; 22,1 and 2,7; 18,2 and 1,8, respectively for calves in Treatments 1 through 5. A saving in pre-weaning feeding costs of 67,0 to 70,0 % occurred for calves in Treatments 1 through 4, compared to calves receiving whole milk.

High rainfall sourveld areas

NUTRITION

N.5341/05/4/1: UTILISATION OF UREA BY LACTATING DAIRY CATTLE COWS WHEN FED ON MAIZE SILAGE IN THE HIGH RAINFALL SOURVELD AREAS AT CEDARA. 1977-1982

R.M. Bredon, K.P. Walsh and T.J. Dugmore

The feeding of maize silage forms the principal part of the winter feeding regime of many Natal dairy farmers. This silage is high in energy but low in protein. A trial was run to evaluate the use of natural protein and urea as protein sources to balance the silage for protein and energy.

Three trials, using Friesian cattle, were run, the first (A) with two treatments, balancing energy using natural protein (H.P.C.) or urea only. In the second trial (B) an extra treatment was added, this being a 50:50 mixture of protein from natural protein and urea. In the third trial (C), a switchover design was used.

Supplementary concentrates (TDN 74, D.C.P. 12,5 %) containing natural protein were fed to all cows (on an individual basis) according to their actual milk and butterfat production. The concentrates were adjusted weekly.

The results presented in Table 1 show that except for trial A the H.P.C. treatment proved significantly better than the urea treatment. In trial A both treatments had poor dry matter intakes (Table 2) due to coarse and long silage.

The H.P.C. + urea treatment differed non-significantly with the urea treatment in trial B and non-significantly with H.P.C. in trial C. This may be caused by the dry matter intakes which follow the same pattern as the milk production.

In trial C there were significant differences in intake ($P < 0,05$) for the urea and H.P.C. treatments over the entire trial period.

The adverse effect of urea upon dry matter intake has previously been reported in the literature. Silage contains very high levels of non-protein-nitrogen (NPN) and these, in addition to the supplemented urea, cause an excessive NPN load on the cow, reducing dry matter intakes.

In all three trials there were no significant differences in body mass changes.

TABLE 1 - Milk production results of cows fed maize silage supplemented either with H.P.C., urea or H.P.C. + urea

	Treatment		
	H.P.C.	H.P.C. + urea	Urea
Trial A			
Initial prod./day (kg/day)	13,45		13,31
91-day cumulative prod. (kg)	1 096,94		1 051,79
Trial B			
Initial prod./day (kg/day)	16,02	15,00	15,63
12-week cumulative prod. (kg)	1 210**	1 084	1 043
Trial C			
Initial prod./day (kg/day)	14,62		14,20
18-week cumulative prod. (kg)	1 600,62*		1 462,21
Period C (includes H.P.C. + urea)	475,02	460,88	428,53**

**Significantly different at $P < 0,01$
*Significantly different at $P < 0,05$

TABLE 2 - Dry matter intakes, as a percentage of body mass, for cows fed maize silage supplemented with H.P.C., urea or H.P.C. + urea

	Treatment		
	H.P.C. %	H.P.C. + urea %	Urea %
Trial A	2,46		2,47
Trial B	2,63**	2,22	2,16
Trial C (H.P.C. + urea period)	2,78	2,59	2,21*

**Significantly different at $P < 0,01$
*Significantly different at $P < 0,05$

LARGE STOCK

MANAGEMENT

N.5341/41/1/2: LARGE STOCK: MANAGEMENT OF BEEF CATTLE ON DIFFERENT VELD TYPES: EFFECT OF SEASON OF MATING ON REPRODUCTION AND WEANING PERFORMANCE OF BEEF CATTLE FEMALES. 1971-1982

A.D. Lyle, G.J.N. Muller and S.F. Lesch

Three calving seasons, *viz* autumn, winter and early summer were used to investigate the most suitable calving period for the highland sourveld of Southern Natal. The mating, calving and weaning dates were as follows:

Calving season	Mating period	Calving period	Weaning date
Autumn	Jun. 1 - Aug. 9	March 12 - May 20	Feb. 1
Winter	Sept. 1 - Nov. 9	Jun. 12 - Aug. 20	May 1
Early summer	Dec. 11 - Feb. 29	Sept. 21 - Nov. 30	May 1

Hereford and Simmentaler cows were allocated to each calving group.

By calving in early summer (September 21 to November 30), 47 % and 33 % of the total digestive nutrients (TDN) fed and 38 % and 14 % of the crude protein (CP) fed could be saved compared with autumn and winter calving, respectively.

Season of calving did not have a significant effect on calving percentage except in the case of the autumn Simmentaler cows whose calving percentage was approximately 20 % lower than the winter and summer groups.

It would thus seem that the time of year when the bulls are joined has no influence on calving percentage provided that the nutrition of the cow is adequate.

In the case of the Hereford cattle winter and summer-born calves performed equally well, with autumn-born calves significantly ($P > 0,01$) poorer in growth. Simmentaler summer and winter-born calves gained mass significantly better ($P > 0,05$) than the autumn-born calves.

There was no significant difference ($P < 0,05$) between steer and heifer live mass gain.

Correcting for cow age had no significant influence on calf masses. Creep feed for calves had no significant effect on either cow or calf mass.

Season of calving from which the heifer originated had little effect on the mating mass of the heifers, though the masses of the autumn-born heifers were less favourable than those of the winter and summer-born heifers.

Feedlot trials indicated that cattle a year older gained mass at an average of 2 kg/day compared with an average mass gain of 0,89 kg/day for weaners when fed *ad lib.* on a ration of *Eragrostis curvula* hay and concentrate.

Data clearly indicate no effect of season on the performance of both the cow and the calf and that the main factor determining performance is the level of nutrition. The availability of feed, that is fodder flow, is the only factor that should be considered when a calving season is decided upon.

SMALL STOCK

REPRODUCTION

N.5342/04/1/1: SMALL STOCK: SUBNORMAL LUTEAL FUNCTION IN EWES AFTER SEASONAL ANOESTRUS IN THE HIGH RAINFALL SOURVELD AREAS AT CEDARA. 1979-1983

J. Grobbelaar

N.5342/04/1/2: SMALL STOCK: EFFECT OF *POST PARTUM* GnRH TREATMENT AND ROLE OF PMSG IN LUTEAL MAINTENANCE IN EWES IN THE HIGH RAINFALL SOURVELD AT CEDARA. 1979-1983

J. Grobbelaar

Subnormal luteal functions in ewes were investigated after ovulation was induced with gonadotrophin releasing hormone (GnRH).

Lactating ewes during early *post partum* were used in the first study. Pregnant mare serum gonadotrophin (PMSG) was administered as a luteotrophin, either as a continuous intravenous infusion or as subcutaneous injections. PMSG, both as an infusion and injection showed significant luteotrophic effects as gauged by progesterone output.

The determination of progesterone secretion *in vitro* during the incubation of luteal tissue showed that the luteotrophic effect of PMSG was the result of larger corpora lutea, and not a greater secretion per unit mass.

Karoo and arid areas

SMALL STOCK

PHYSIOLOGY

K.5352/03/2/5: SEASONAL CHANGES IN SEXUAL ACTIVITY AND SEMEN QUALITY IN THE ANGORA RAM. 1979-1984

P.G. Loubser, C.H. van Niekerk and L.J.J. Botha

The seasonal changes in libido and peripheral venous plasma concentrations of testosterone and luteinising hormone of the Angora ram, were investigated. A definite breeding season from March to the end of July was determined. Libido, as well as the levels of testosterone and luteinising hormone followed a seasonal pattern with change in photoperiod being the main stimulus for seasonal sexual variations.

The seasonal changes in semen quantity and quality in the Angora ram regarding ejaculate volume, semen pH, sperm concentration, sperm motility, percentage live or normal sperm cells and survival of sperm cells during the freezing process were investigated. Only ejaculate volume yielded a significant seasonal pattern.

Central grassveld areas

LARGE STOCK

NUTRITION

V.5361/05/1/1: LARGE STOCK: A STUDY OF THE EFFECT OF THE P STATUS ON THE PRODUCTION AND REPRODUCTION OF BEEF CATTLE GRAZING THE NATURAL PASTURES OF GLEN. 1978-1984

M.P.V. Read

V.5361/05/1/2: LARGE STOCK: A STUDY OF THE EFFECT OF THE P STATUS ON THE PRODUCTION AND REPRODUCTION OF BEEF CATTLE GRAZING THE NATURAL PASTURES OF ARMOEDSVLAKTE. 1978-1984

M.P.V. Read

Animal performance from natural pasture was investigated at two experimental sites: Glen and Armoedsvlakte. This proved feasible when P was supplemented, although the two sites differed vastly in the degree of P deficiency experienced by the cattle. The seasonal variation in other nutrients (i.e. crude protein content and organic matter digestibility of the pasture) was characterised.

Owing to selective grazing behaviour, pasture samples collected by oesophageally fistulated cattle and sheep proved to be of a consistently higher quality than those collected manually. Of the indicators used to monitor the P status of grazing ruminants (rib bone, blood and faeces) rib bone samples proved the most promising. The P concentration in rib bone samples from sheep at Armoedsvlakte equalled those of cattle in an extreme state of deficiency, thereby uniquely identifying a P deficiency in sheep, despite the absence of any apparent effects on their performance.

Winter rain cropping areas

PIGS

NUTRITION

W.5374/05/1/1: OPTIMAL FISH MEAL LEVELS IN DIETS FOR GROWING PIGS IN THE WINTER RAIN CROPPING AREA. 1978-1983

N.M. Kritzinger

Diets containing three levels of fish meal (4; 6 and 8 %), each supplemented with synthetic lysine at four levels (0,7; 0,8; 0,9 and 1,0 %) were formulated to contain 12,65 MJ of metabolisable energy (ME) per kg air-dry feed and individually fed *ad lib.* to 48 Landrace x Large White pigs (24 boars and 24 gilts) for the live mass interval 20 to 60 kg. Feed intake and live mass changes were recorded at three-day intervals during the experimental period. Average daily gain and feed conversation ratio for each pig were calculated while individual carcass measurements (backfat thickness, C + K measure and eye muscle area) were taken after slaughtering at 60,7 ± 0,9 kg live mass. These results are presented in Table 1.

Fish meal level significantly ($P < 0,05$) affected feed utilisation but had no significant effect on any of the carcass traits studied. Growth rate was only non-significantly improved with increasing protein levels. Lysine level had no significant effect on any of the parameters studied while sex significantly ($P < 0,05$) affected growth rate, feed utilisation and eye muscle area.

For both sexes live mass gain and feed utilisation improved with an increase in dietary fish meal level from 4 to 8 % while an increase in lysine level above the basic level of 0,70 % had no beneficial effect on any of the performance parameters studied.

It is therefore concluded that at a minimum level of 0,70 % lysine in maize meal-based diets for growing pigs, some other amino acids may be considered limiting. Identification and supplementation of those

TABLE 1 - The effects of fish meal level, lysine level and sex for the live mass interval 25 to 60 kg

	Fish meal level (%)			Lysine level (%)				Sex	
	4	6	8	0,7	0,8	0,9	1,0	Boars	Gilts
Feed intake (g/day)	2 327	2 210	2 163	2 272	2 196	2 231	2 236	2 274	2 193
Live mass gain (g/day)	680	695	722	713	694	694	695	746a	653b
Feed utilisation (kg/kg gain)	3,47a	3,23ab	3,04b	3,21	3,21	3,25	3,29	3,10c	3,25d
Backfat thickness (mm)	13,4	14,0	14,1	12,5	14,2	13,0	15,8	14,0	13,7
C + K measure (mm)	27,6	28,9	24,6	23,8	27,9	25,1	31,2	29,0	25,1
Eye muscle area (cm^2)	37,0	35,5	35,6	38,2	36,5	35,6	33,7	34,5a	37,5b

Significant ($P < 0,05$) effects are denoted by different superscripts

limiting amino acids are important prerequisites for recommendations about the optimal fish meal and lysine levels in such diets.

RESOURCE UTILISATION RESEARCH (PASTURES)

Bushveld areas

CULTIVATED PASTURE

POTENTIAL STUDIES

V.5413/36/1/1: DRY MATTER PRODUCTION, DIGESTIBILITY AND CHEMICAL COMPOSITION OF *ANTHEPHORA PUBESCENS*: AN ECOTYPE EVALUATION ON A SOIL OF THE MANGANO SERIES. 1976-1983

J.H. Fourie, L.G. du Pisani and Margarietha A. Baard

Production and quality of five promising *Anthephora pubescens* ecotypes (VH4, VH7, VH9, VH17 and VH20) at two fertiliser levels were compared on a soil of the Mangano series (Hutton form). The highest yield was obtained from VH7 and VH20 with an average DM production of 4 257 and 4 140 kg/ha, respectively. The DM production of all ecotypes increased at the higher level of fertilisation. The chemical composition (P, K, Ca, Mg and Zn), crude protein content and *in vitro* digestibility of the ecotypes did not differ significantly. Possible deficiencies of P and Zn in plant material for optimal animal production were indicated. There were no differences as to the influence of ecotypes on the mineral content of the soil. The necessity for phosphate fertilisation was obvious, while a possible need for application of zinc and lime or dolomitic lime was indicated.

Anthephora pubescens is a perennial, tufted grass with a characteristic rosette of basal leaves and long, thin stems of 400 mm to 1,2 m in height. Roberts & Fourie (1975) described it as a very palatable climax grass found on a variety of soils. According to Donaldson & Kelk (1974) *A. pubescens* is a potentially valuable species in cultivated pastures and is prevalent in regions with an annual rainfall of 250 mm to 650 mm.

The most outstanding characteristics of *A. pubescens* are the following:

- It is strongly perennial
- It is easily grown from seed
- Produces well on poor soil (low nutrient content)
- Is highly palatable.

The study was conducted at the Vaalharts Agricultural Research Station, approximately five km south of Jan Kempdorp. The Vaalharts Research Station is located at 27°57' S, 24°50' E and 1 175 m above sea level. The veld type could be described as Mixed *Tarchonanthus*-Thorn Veld (Acocks, 1975; No. 16b4). The long-term average rainfall for Vaalharts is 445 mm/a.

Five *A. pubescens* ecotypes, namely VH4, VH7, VH9, VH17 and VH20 identified in a preliminary evaluation programme, were tested. Each ecotype was grown at a low and high level of NPK fertilisation, namely 25 kg N, 8 kg P and 50 kg K/ha and 75 kg N, 24 kg P and 50 kg K/ha, respectively.

The five ecotypes, in combination with the two fertiliser levels, were randomised in a 5 x 2 factorial design with three replications. The size of the plots was 50 m² (8,33 x 6 m) with side rows of 2 m between plots. The interrow spacing was 1,5 m. The annual phosphate and potassium applications took place simultaneously after the first spring rains. The nitrogen was applied in two equal portions, the first with the P and K and the second immediately after the first cutting.

Plots were harvested individually with a hand-operated, petrol-driven mower when all three replications of a specific ecotype reached the early flowering stage. The yield of the plots was determined on the site, while a representative sample was taken simultaneously to determine DM in order to estimate DM yield per hectare. Samples from the three replications for each ecotype were then combined and analysed for N, P, K, Zn, Ca and Mg content. *In vitro* digestibility of these samples was also determined. Prior to the onset and after completion of the trial, soil samples were taken at random at two depths (0-300 mm and 310-600 mm) for soil analyses. Standard laboratory procedures were used.

An analysis of variance applicable to a factorial experiment was used to analyse phytomass production. As the chemical analysis results were based on combined samples from the three replications, the highest order interaction was used as error term. Although this procedure may be criticised there was no alternative available. The means were statistically compared, using Tukey's multiple comparison test.

The rainfall during the experimental period may be described as normal, with an above average precipitation in 1976/77 (511 mm) and 1977/78 (574 mm) but below average during 1978/79 (366 mm). Average rainfall over the three growing seasons compared favourably with the long-term mean.

Statistically significant ($P \leqslant 0,05$) differences in DM production occurred between ecotypes during two of the three growing seasons. Production of ecotypes over the three seasons at the low fertiliser level (25 kg N, 8 kg P and 50 kg K/ha) did not differ significantly. The average DM production at this level of VH4, VH7, VH9, VH17 and VH20 was 3 375, 3 812, 3 791, 3 746 and 3 673 kg/ha, respectively. At the higher fertiliser level (75 kg N, 24 kg P and 50 kg K) VH7 produced significantly ($P \leqslant 0,01$) more DM than VH4, VH9 and VH17, while VH20 produced significantly ($P \leqslant 0,01$) more DM than VH4, VH9 and VH17, while VH20 produced significantly ($P \leqslant 0,05$) more than VH9 and VH17. The mean DM production of the ecotypes at the high fertiliser level for the above-mentioned ecotypes was 4 156, 4 701, 4 089, 4 093 and 4 607 kg/ha, respectively. A statistically significant ($P \leqslant 0,05$) interaction between fertiliser level and ecotypes occurred during two seasons. VH7 and VH20 produced significantly ($P \leqslant 0,05$) more at the high fertiliser level in both these seasons, whereas VH4 produced significantly ($P \leqslant 0,05$) more at the high level during one season only. The mean DM production of ecotypes over the three seasons was significantly ($P \leqslant 0,01$) greater at the high than at the low fertiliser level. There appeared to be no differences in the growth cycles of the different ecotypes during the experimental period. Soil moisture content was directly related to growth rate.

The differences between the various ecotypes concerning chemical composition were insignificant. The P content of the plant material (0,08 % P) was extremely low at the onset of the trial. This can be attributed to the very low P content (1 to 7 mg/kg) in the soil. Application of superphosphate resulted in a P content of the plant material in summer which was higher than the acceptable level of 0,20 to 0,48 % required for optimal animal production. However, the P content of 0,08 % during winter was still too low for optimal animal production. The content of K, Ca and Mg in the plant material of the ecotypes was 4,39 %, 0,98 % and 0,98 %, respectively. The Zn content (27 mg/kg) was apparently too low for optimal animal production (50 mg/kg). This deficiency may be attributed to the very low level of Zn in the soil, which tended to decline during the trial. It must be borne in mind, however, that chemical analyses of samples representing the entire plant were done, whereas grazing animals are able to select portions of plant which provide a diet of a considerably higher nutritive value.

Both crude protein content and *in vitro* digestibility of *A. pubescens* ecotypes were relatively high. Crude protein content varied from 12,7 % in the summer (flowering stage) to 5,8 % in winter (mature stage). The *in vitro* digestibility of organic matter was above 50 % in winter and reached the highest level, i.e. 61,8 %, in the flowering stage. The ecotype VH17 had a significantly higher ($P \leqslant 0,01$) digestibility than both VH4 and VH20. Growth stage was the main factor influencing crude protein content and digestibility.

Ecotypes did not have a statistically different influence on the mineral content of the soil. With each ecotype the P, K, Zn, Ca and Mg contents of the soil were reduced, apparently as a result of material harvested. This happened in spite of the P and K applications.

In conclusion it can be stated that the DM production of ecotypes VH7 and VH20 was significantly higher than that of other ecotypes under investigation. However, the *in vitro* digestibility of these two ecotypes was slightly lower. Although NPK fertilisation increased the DM production of all species, the financial implications of such a fertilisation programme must always be taken into account. At the present prices of LAN, superphosphate and potassium chloride, fertiliser costs amounted to R52,70/ha and R112,72/ha at the low and high level of fertilisation, respectively. This implies that VH7 and VH20, which realised increases of 888 kg DM/ha and 943 kg DM/ha, respectively, with the increase in level of fertilisation, produced the extra DM at a cost of approximately R60,00/ha.

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V.5413/41/1/1: DRY MATTER PRODUCTION, DIGESTIBILITY AND CHEMICAL COMPOSITION OF *ANTHEPHORA PUBESCENS*: AN ECOTYPE EVALUATION UNDER GRAZING CONDITIONS. 1976-1982

J.H. Fourie, L.G. du Pisani and Margarietha A. Baard

The reaction of five promising *Anthephora pubescens* ecotypes (VH4, VH7, VH9, VH17 and VH20) to grazing was investigated on a soil of the Mangano series (Hutton form). VH20 provided the highest number of grazing days, and a grazing capacity of 2,68 ha/LSU (large stock unit), at a high grazing intensity in the ripe-seed stage, was obtained. The high quality of *Anthephora* grazing was reflected in the protein content (14,1 %) and *in vitro* digestibility (69,9 %) of grazing material obtained by means of oesophageally fistulated steers.

Anthephora pubescens is a perennial, tufted grass with a characteristic rosette of basal leaves and long, thin stems of 400 mm to 1,2 m in height. Roberts & Fourie (1975) described it as a very palatable climax grass found on a variety of soil types, but more generally associated with poor sandy soil. According to Donaldson & Kelk (1974) *A. pubescens* is a potentially valuable species in cultivated pastures and is prevalent in regions with an annual rainfall of 250 mm to 650 mm.

The most outstanding characteristics of *A. pubescens* are as follows:

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The study was conducted at the Vaalharts Agricultural Research Station, approximately five km south of Jan Kempdorp. Vaalharts is located at 27°57' S, 24°50' E and 1 175 m above sea level. The veld type is described by Acocks (1975) as the mixed *Tarchonanthus*-Thorn Veld (No. 16b4). The long-term average rainfall for Vaalharts is 445 mm/a.

Five *A. pubescens*-ecotypes, namely VH4, VH7, VH9, VH17 and VH20 with the best production in a preliminary investigation, were evaluated with grazing cattle. The number of grazing days for each ecotype was determined with steers. Two grazing systems were used as treatments. In Treatment I a low intensity grazing was practised in the early flowering stage and in Treatment II a high intensity grazing was practised in the ripe-seed stage.

The high and low intensity grazing resulted in the removal of approximately 50 % and 80 % of the available phytomass, respectively. During the 1978/79 season five plots were cut in each treatment before grazing, to estimate available phytomass. After grazing, five plots adjacent to those previously cut, were harvested in order to determine the phytomass removed by grazing and trampling. The leaves and stems of the different ecotypes were separated. Owing to the fact that there was no replication of treatments, the number of grazing days was not statistically compared.

In the 1979/80 season VH20 was sampled by means of oesophageally fistulated animals. Particular interest was attached to the crude protein content and digestibility of the plant material collected by the fistulated animals. Three oesophageally fistulated animals per treatment were used. Five treatments were evaluated, namely:

(a) 50 % utilisation in October (spring growth)
(b) 50 % utilisation in February (50 % flowering stage)
(c) 85 % utilisation in February (50 % flowering stage)
(d) 50 % utilisation in May (100 % ripe-seed stage)
(e) 85 % utilisation in May (100 % ripe-seed stage)

CULTIVATED PASTURE

An analysis of variance applicable to a factorial experiment with five treatments and three sampling animals per treatment, was used. The significance of differences amongst treatment means was investigated by means of linear contrasts.

During the experimental period, higher than average rainfall was experienced in the 1977/78 season (574 mm), whereas below average rainfall was experienced during the 1978/79 (360 mm) and 1979/80 (384 mm) seasons.

During the 1977/78 season the grazing days for the ecotypes with the same treatments did not vary greatly, namely 80 grazing days in Treatment I and 96 grazing days in Treatment II. The only statistical difference amongst ecotypes was that VH20 in Treatment II provided a higher number of grazing days (112) than the other ecotypes. During the 1978/79 season VH20 provided a higher number of grazing days, in both treatments, than the other types, whereas VH4 provided the least number of grazing days. On average there was not much variation between the grazing days on VH7 (94 days), VH9 (104 days) and VH17 (98 days), with VH20 (112 days) and VH4 (81 days) providing the highest and lowest number of grazing days, respectively. The lower mean number of grazing days for Treatment I (88 days) compared with Treatment II (112 days), can be ascribed mainly to the higher intensity of grazing in Treatment II (ripe-seed stage). Treatment II was also grazed later in the season than Treatment I (flowering stage) when most types have more available phytomass.

In the cutting trials the leaf to stem ratio for all five ecotypes was more favourable in the ripe-seed stage than in the early flowering stage. The leaf to stem ratio was more favourable in the early flowering stage after grazing than before grazing. This indicates that stem utilisation took place to a large extent in the flowering stage. According to data collected, VH7 and VH9 had the poorest and VH4 the best leaf to stem ratio. The mean leaf to stem ratio for VH4, VH7, VH9, VH17 and VH20 were 2,8:1; 1,3:1; 1,5:1; 2,0:1 and 1,8:1, respectively.

Both the crude protein content and *in vitro* digestibility of the grazing material collected from VH20 by means of fistulated steers were, in October and February, significantly ($P \leqslant 0,01$) higher than in May. The mean crude protein content of the grazing material in October (leaf stage), February (flowering stage) and May (ripe-seed stage) was 15,9 %, 16,5 % and 11,1 %, respectively, whereas the *in vitro* digestibility was 72,3 %; 71,3 % and 66,9 %, respectively. The intensity of grazing did not have a significant influence on the crude protein content and digestibility of the plant material collected by oesophageally fistulated animals.

According to this investigation, VH20 provided the highest number of grazing days. With a high intensity of grazing in the ripe-seed stage the mean number of grazing days (136) on VH20 is equivalent to a grazing capacity of 2,68 ha/LSU. The mean crude protein content (14,1 %) and digestibility (69,9 %) of VH20 collected by means of fistulated steers were rather high. VH7 and VH9 had a poorer leaf to stem ratio than the other ecotypes.

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Summer rain cropping areas

RADICAL VELD IMPROVEMENT

NUTRITION

H.5422/05/1/3: THE EFFECT OF SELECTIVE DEFOLIATION AND FERTILISATION ON *CYMBOPOGON-THEMEDA* VELD IN THE SUMMER RAIN CROPPING AREAS. 1970-1983

R.H. Drewes

Apparently it is possible to gain a considerable amount of information on the reaction of individual

grass species and the sward as a whole, from the selective defoliation of small plots, and to relate this to grazing practice. This technique has the advantages that small areas of land are required, it is not costly, homogeneous experimental areas are possible and relatively little labour is required. Thus many more trials and more treatments in each trial become practical possibilities. Trampling and the return of nutrients could be introduced into the experiments by means of muzzled sheep.

The results of this experiment indicate that defoliation practices can influence and even reverse the reaction of the so-called "increaser" and "decreaser" species under fertilisation.

In the sward under consideration, it would appear that highly selective grazing, high production grazing and light mowing produce the most favourable response in terms of plant basal cover. Moderately heavy selective grazing would probably produce unfavourable responses.

Under a specific sward composition (i.e. a high percentage of both *C. plurinodis* and *T. triandra*), non-selective grazing would appear to have merit as a temporary reclamation measure.

RADICAL VELD IMPROVEMENT

CROP SCIENCE

H.5422/30/1/2: THE VALUE OF DIFFERENT PASTURE CROPS ON RADICALLY IMPROVED VELD FOR MEAT PRODUCTION IN THE SUMMER RAIN CROPPING AREAS. 1973-1983

R.H. Drewes

An experiment to investigate various ways in which marginal soils can be intensified for fodder production, was carried out over a four-year period at the Agricultural Research Institute of the Highveld Region at Potchefstroom.

Treatments were as follows:

- Veld with no disturbance

  B0 = veld (control)
  B1 = veld + fertilisation

- Veld worked with a tine implement

  B2 = B1 + Smuts finger grass sown broadcast
  B3 = B1 + legumes sown broadcast

- Veld ploughed and fine seed bed prepared

  B4 = B1 + Smuts finger grass in rows
  B5 = B1 + Smuts finger grass + legumes in alternate rows
  B6 = B1 + Coastcross II planted with runners

The fertiliser on treatments B1, B2, B4 and B6 consisted of 100 kg N/ha (as limestone ammonium nitrate 28 %) and 10 kg P/ha (as superphosphate 11,3 %) applied in one dressing in early spring. Treatments B2 and B4 were given 20 kg N and 30 kg P/ha (sources as before), also applied in early spring. The legumes were lucerne, *Macroptilium atropurpureus* and *Desmodium intortum*.

Each of these treatments was applied in two replications on the following soil series:

G0 = Williamson (Glenrosa form)
G1 = Gelykvlakte (Arcadia form)
G2 = Glendale (Shortlands form)

The treatments on each soil series were grazed by year-old oxen whenever sufficient grazing was available to last for a minimum of 14 days. The oxen were mass-measured before and after grazing the individual treatments of a particular soil series.

The highest mass gains of 326,0; 284,1 and 262,0 kg/ha were obtained from the Smuts finger grass (ploughed), the Coastcross II and the Smuts finger grass (tilled). These yields did not differ significantly at the 1 % level from one another, but they were all higher ($P < 0,01$) than the mass gains obtained on the two legume treatments (B3 and B5). The average mass gain/ha on all the fertilised treatments (B1 to B6) was 4,5 times more than the figure realised on the control (B0).

RADICAL VELD IMPROVEMENT

When evaluating the grazing days per hectare, it again appeared that the highest yield was obtained on the Smuts finger grass in rows (B4) treatment. The number of grazing days obtained on this tratment was in fact highly significantly ($P < 0,01$) more than the figure obtained on the Smuts finger grass on the tilled soil (B2), or the Coastcross II on the ploughed soil (B6).

The dry matter production generally followed the same trend as the previous two parameters, but in this case no statistically significant differences at the 1 % level emerged between the fertilised veld (B1), the Smuts finger grass (B2, B4) and the Coastcross II. The Glendale and Williamson series generally performed better ($P < 0,01$) for all three parameters than the Gelykvlakte series.

The highest return over fertiliser cost was R260,12/ha obtained from the Smuts finger grass (B4), this figure being considerably more than the comparable figure of R60,50/ha obtained on the control (B0). On the Smuts finger grass treatment a grazing capacity of 3,7 oxen/ha for the summer period (110 days) and an average daily gain (ADG) of 0,8 kg/ox were achieved. For the same period the veld carried 0,9 oxen/ha with an ADG of 0,6 kg/ox.

High rainfall sourveld areas

CULTIVATED PASTURE

CROP SCIENCE

D.5443/30/1/3: EVALUATION OF *FESTUCA ARUNDINACEA* IN THE HIGH RAINFALL SOURVELD AREAS OF THE EASTERN CAPE. 1980-1983

L.O. Nel

Thirteen cultivars of *Festuca arundinacea* were compared at Dohne in terms of dry matter yield and growth pattern. After establishment the experiment was affected by a spring drought and poor distribution of rain during the summer period of the first season. The climate pattern was repeated during the second season and poor yields were obtained. During the third season the fescue died out altogether on most of the plots.

These results confirm the results of earlier research work done at Dohne, *viz* that the rainfall is too unreliable to recommend the dryland establishment of those cultivars of temperate grass species currently available.

CULTIVATED PASTURE

CROP SCIENCE

N.5443/30/2/1: PLANTING TIMES FOR *LOLIUM MULTIFLORUM* IN THE HIGH RAINFALL SOURVELD AREAS AT CEDARA. 1977-1982

D.C.W. Goodenough, C.I. Macdonald and A.R.J. Morrison

The main objectives in this facet were to determine the optimum time to establish an Italian rye grass pasture and to ascertain whether postponement of the normal autumn planting until the August-December period, would delay flowering and the subsequent dying off of this annual temperate grass until the second summer after planting.

Five different Italian rye grass cultivars were planted under irrigation with high fertiliser levels at 36 consecutive monthly plantings (two replications) on two sites at Cedara, *viz* a well-drained upland site on a Doveton soil of the Hutton form, and on bottomland on a poorly drained Katspruit soil type. The traditional early February to early March plantings appear to be the optimum to ensure late autumn, winter, spring and early summer grazing before the grass goes to seed and dies off. Some difficulty was however experienced on the bottomland site with waterlogging and uneveness of growth, depending on the season.

The locally bred Midmar Italian rye grass appears to be best suited to such February/March plantings and first utilisation may generally be made six weeks (sheep) to eight weeks (cattle) after planting. Early establishment of Midmar will also guarantee that the grass is fully mature when the late autumn/winter cold sets in, thus ensuring optimum winter production. Adequate irrigation at establishment is essential and it

should also be noted that early February plantings may expect a low to moderate infestation of broad-leaved weeds which may necessitate control by a selective broad-leaf weedicide.

Plantings made in April or later were very much slower to establish, particularly on the cooler bottomland site, and this practice is not recommended.

Plantings conducted during August or later, resulted in very little flowering in December of the same year, thus allowing the five Italian rye grass cultivars to persist for up to 16 months before dying off. Although good herbage yields may be expected in the months immediately following such unseasonal August/September plantings, infestation by summer weeds and most important, little or no growth during the late autumn and winter months in the year following planting, despite adequate fertiliser and irrigation applications, preclude recommending Italian rye grass as a "biennial" pasture. On the other hand, it was interesting to note that the tetraploid cultivar Tetrone, following an August or September planting, yielded reasonably well during the so-called "autumn gap" (February/March) period when dairy farmers very often face a shortage of high-quality forage and consequent reduction in milk yield.

November to January plantings are definitely not advisable because of severe infestation by warm season weeds, mainly grasses, which cannot be easily controlled with weedicides without adversely affecting the Italian rye grass.

CULTIVATED PASTURE

CROP SCIENCE

N.5443/30/5/6: COMPARISON OF VARIOUS TROPICAL GRASSES AND LEGUMES ON A DOVETON SOIL IN BIOCLIMATE 4F. 1973-1982

N.N. Gray

N.5443/30/5/7: COMPARISON OF VARIOUS TROPICAL GRASSES AND LEGUMES ON A ARROCHAR* SOIL IN BIOCLIMATE 4F. 1973-1982

N.N. Gray

The mean annual dry matter yields and the seasonal distribution of yield of seven tropical grass species and one legume were determined over a seven-year period at Kokstad on a deep well-drained red soil of the Doveton series and on a shallow Newport soil tending towards a Mispah in places.

The mean annual dry matter yields (kg/ha) of the species evaluated over a seven-year period (1973-1980) on the two soil types (first figure = Doveton soil; second figure = Newport/Mispah soil) were as follows: *Pennisetum clandestinum* (high N): 13 149; 7 306; *Digitaria eriantha*: 10 873; 9 363; *D. valida*: 10 746; 8 943; *Cenchrus ciliaris*: 8 210; 6 202; *P. clandestinum*: 7 987; 4 307; *Cynodon dactylon*: 7 411; 7 779; *Acroceras macrum*: 6 257; 6 191; and *Desmodium uncinatum*: 3 795; 3 956. With the exception of *P. clandestinum* (high N), which received 80 kg N/ha, all species received 40 kg N/ha in spring and again after each cut.

The average seasonal distribution of yield for all species on both soil types differed significantly from one another in January only. Although differences in other months were not significant, there was a tendency for production to be more evenly spread over the season for species on the Doveton soil than on the shallower Newport/Mispah soil. The high herbage yields achieved by some species, notably *D. eriantha* and kikuyu, at a relatively low level of N fertilisation, are of considerable value to semi-intensive beef and sheep producers in Bioclimatic subregion 4f of Natal. The effect of soil type on yield must be considered when selecting a pasture species. The reason for soil type having little effect in the case of some species, i.e. *C. dactylon* cv. Coastcross II and *A. macrum*, is not entirely clear and requires further investigation if these species are considered important.

The yield data were subjected to a multiple regresssion analysis to assess the influence of such factors as age of pasture, soil type, cutting frequency, N level, rainfall and temperature on yield, and regression models were developed. Seasonal distribution curves were developed for all species, using the Richard's function.

*Later defined as a Newport/Mispah transitional soil

CULTIVATED PASTURE

CROP SCIENCE

N.5443/30/7/2: EVALUATION OF COLD TOLERANCE OF KIKUYU. 1977-1979

J.K. Arnott

Four kikuyu seedling cultivars comprising two Cedara selections, one from Australia and one from the United States of America were evaluated at the Kokstad, Tabamhlope and Cedara Research Stations.

The Cedara site proved to be the most suitable and the seedlings became established in the first season, facilitating the collection of all the necessary data. At the other two sites the experiment had to be resown and thereafter only ratings were done, owing to a poor establishment and weed competition.

The results obtained showed that November was the best month in which to sow the seed. Weed competition played a major role in establishment failure and even in a relatively weed-free seed bed the seedlings are very vulnerable for about six weeks.

Seed germination of all cultivars was good (average of 80 %) but it was apparent that seedlings must be carefully nurtured for about six months after germination, i.e. light grazing and topping the weeds afterwards.

Winter kill of the seedlings was complete at Tabamhlope and the runners frosted back to the parent plant at the other two sites. All four cultivars in the trial appeared to be resistant to "yellows" disease.

During the second season of the trial, Whittet, sown in November, yielded 5 233 kg/ha of dry matter which was significantly higher than the yields of any of the other cultivars at the 1 % level.

CULTIVATED PASTURE

MANAGEMENT

N.5443/41/1/3: CHARACTERISATION OF *ERAGROSTIS CURVULA* WITH THE GRAZING ANIMAL IN BIOCLIMATE 4F. 1976-1981

G.M. Brockett, N.N. Gray and A.D. Lyle

An *Eragrostis curvula* pasture was evaluated over a three-year period under grazing at the Kokstad Research Station, using Hereford type yearling steers. The pasture was grazed using a continuous and rotational grazing system, each at two different stocking rates. The rotational grazing system was based on a four-paddock system with a grazing period of one week in each paddock.

The seasonal pattern of grass growth in both the cutting and grazing trials showed a distinct drop in growth rate in spring, a relatively low growth rate over the early summer period, rapid growth over the January/February period, followed by a declining growth rate in autumn.

The seasonal pattern of animal growth followed a similar trend. Average daily gain (AGD) commenced at between 0,8 to 0,5 kg in the spring/early summer, depending on stocking rate, declined to a low figure towards the end of December and rose again in January/February to between 0,25 and 0,5 kg/day.

As was expected, individual animal performance declined with increasing stocking rate. For example, the ADG of the steers over the November to March period declined from 0,43 kg at a stocking rate of 7 steers/ha to 0,37 kg at 10 steers/ha. Gains in the early summer period were higher at both stocking rates. Animal performance was more sensitive to stocking rate in the drier years, particularly where a continuous system of grazing was used. In general animal performance was lower in the wetter seasons.

The results showed no significant difference in animal performance between the continuous and rotational grazing systems at the lighter stocking rate (i.e. 7 steers/ha), whereas at a high stocking rate (10 steers/ha) the rotational system showed definite advantage, particularly in the drier season. The superiority of the rotational system in these instances can be attributed to the rationing effect of the system and the period of rest the plant receives between grazings.

VELD

ANNUAL FODDER CROPS

PATHOLOGY

N.5445/19/1/1: CONTROL OF *CERCOSPORA* LEAF BLIGHT IN JAPANESE RADISH IN THE HIGH RAINFALL SOURVELD AREAS AT CEDARA. 1978-1981

A.S. Hall

The popularity of Japanese radish (*Raphanus sativus* var. *longipinatus*) as a winter forage crop has increased considerably and it has become an important crop, especially in the milk-producing areas of Natal. This increase in popularity is mainly due to the drought resistance, high yields and quick growth as well as its fairly low production costs.

During the past few seasons the yields on many farms in the Natal area have decreased due to attack by leaf-spot diseases. These include *Alternaria brassicae, A. brassicicola* and *Cercosporella brassicae*. The latter is the most important disease. *Colletotrichum higginsianum* was identified only once from leave lesions on Japanese radish grown at Cedara, whereas the other diseases are widespread.

Fungicidal control of the disease was shown to be possible. Significant disease control was obtained with Brestan wettable powder (wp) but Daconil (wp) and Benlate (wp) also gave good control. The problem with a comprehensive spray programme as used in this study is the fairly high cost involved. Therefore, in order to decrease the dependence on fungicidal sprays, farmers can take other precautionary measures. These include at least a two-year rotation of the land used for Japanese radish production, eradication of any cruciferous weeds in the vicinity, as these might act as hosts which carry the fungi over to the next season's crop, and treatment of the seed.

The heat treatment of seed (50 °C for 25 min) must be considered as other pathogens of Japanese radish reported in South Africa, apart from those mentioned in this study, are seed-borne. These include *A. raphani* and *Phoma lingam*, the causal organisms of leaf spot and/or wirestem and black leg, respectively.

The treatment of seed prior to planting as well as the above measures will control the initial early spread of the disease and therefore result in a significant decrease in the use of costly fungicide sprays during the season.

Karoo and arid areas

VELD

ECOLOGY

K.5451/27/1/2: THE INFLUENCE OF CLIMATE ON VEGETATION IN THE KAROO: SIX VELD TYPES AT GROOTFONTEIN COLLEGE OF AGRICULTURE. 1970-1983

M. Vorster

It is well known that the climate is mainly responsible for the establishment and maintenance or modification of plant formations. The influence of climate and weather conditions on the vegetation in South Africa has only been investigated in broad terms. A more detailed knowledge of this influence is very important, not only to explain certain phenomena, but also in the application of practical veld management principles.

This facet was conducted on six different veld types at the Grootfontein College of Agriculture from 1971 to 1978. A representative site on each veld type was selected. In each of these sites, five plants of 10 selected plant species were selected on which monthly phenological data were collected. Meteorological data in terms of rainfall, minimum and maximum air temerature, as well as daily variation of wind, were measured twice weekly.

The phenological data were grouped into different homogeneous groups by means of a K-means clustering analysis ordination technique. Standard correlation coefficients and one-way analysis of variance statistical techniques were applied to test any relationships between the phenological and meteorological data.

Rainfall had a strong positive relationship with the relative vegetative growth activity (RVGA) and relative reproductive activity (RRA) of the grasses, while no relationship was found in terms of the karoo bushes (dwarf shrubs). This can probably be ascribed to the fact that the karoo bushes with their deeper root systems were more dependent on the deep-seated soil moisture than on the surface soil moisture.

Minimum air temperature did have a great positive influence on the RVGA and RRA of the grasses, while this was not the case with the karoo bushes. The grasses preferred high minimum air temperatures for active vegetative and reproductive activity. It seemed that the palatable karoo bushes also preferred high air temperatures for active reproductive activity and the unpalatable karoo bushes preferred low air temperatures.

Although maximum air temperature did not have a great influence on the RVGA and RRA of the plants in general, it did cause a decrease in the RVGA of the plants in midsummer.

Active vegetative and reproductive growth of the plants were also associated with low wind speeds.

It also appeared that daylight length might play a significant role in the RRA of the plants, because it was observed that maximum reproductive activity was obtained when daylight length was moderate (i.e. autumn and spring).

The influence of these climatic factors, collectively and separately, as well as the inherent characteristics of the plants, was clearly illustrated in the seasonal rhythm of the vegetative and reproductive activity of the plants. The seasonal RVGA of the plants was characterised by a moderate activity during early summer, followed by a decrease in activity in the midsummer and subsequent high activity during the late summer. In the winter there was a reduction in activity. The seasonal RRA was characterised by two active periods, *viz* early and late summer. The grasses and palatable karoo bushes reached maximum RRA in the late summer, while the unpalatable karoo bushes attained maximum RRA in the early summer.

It was also evident that the veld types did not play a significant role in the RVGA and RRA of the different plants. This can probably be ascribed to the fact that the variation in veld types was not drastic enough to warrant any differences.

The results of this facet have shown that certain climatic factors and inherent characteristics exert a strong influence on both the vegetative and reproductive activity in the Eastern Mixed Karoo. Adequate soil moisture, moderate maximum and minimum air temperatures and low wind speeds appear to be necessary for high levels of vegetative growth activity. Providing that one or more climatic factors are not too extreme, it is apparent that moderate daylight length is important for high levels of reproductive activity.

Veld types have no significant influence on the vegetative and reproductive activity of the plants considered.

RADICAL VELD IMPROVEMENT

MANAGEMENT

K.5452/41/1/1: VELD RECLAMATION: UTILISATION AND MANAGEMENT OF *PHRAGMITES AUSTRALIS* (COMMON REED). 1978-1983

P. Botha and A.S.J. Barnhoorn

This facet was conducted on the farm Spitskop in the Tarka Conservation Area, Hofmeyr, at different soil conservation dams. The facet consisted of four experiments, *viz* grazing by Afrikaner cattle, grazing by Merino sheep, mowing and burning. The experiments consisted of different treatments.

The grazing experiments consisted of the following treatments:

- Grazing in early summer
- Grazing in midsummer
- Grazing in autumn
- Grazing in early winter
- Grazing in late winter
- No grazing (control)

The mowing experiment consisted of the same treatments as the grazing experiment but the plots were mowed instead of grazed. The treatments of the burning experiment comprised of burning every year in late winter, every second year in late winter and every three years in late winter. Owing to practical problems in the application of the treatments no results of the burning experiment and very little information on the mowing experiment were obtained. These two treatments were therefore disregarded in the discussion of the results.

The collection of data was performed at the following sampling periods:

- Early summer (mid-October - mid-November)
- Late summer (January)
- Autumn (mid-March - mid-April)
- Early winter (mid-May - mid-June)
- Late winter (August)

At each sampling period data were collected from the six plots of each experiment (i.e. sheep grazing, cattle grazing and mowing) to provide information on:

- Phytomass/plot
- Density/plot
- Average mass/plant
- Average plant height

From the plot that was to be grazed according to the treatments the above data were collected before and after grazing. The number of animals that were to occupy the plot was calculated from the before-grazing phytomass/plot determination, with a 14-day occupation as aim.

Sheep-grazing experiment

The results showed no significant difference ($F < 4,35$) in any of the determinations for the control plot and the early summer and late winter treatments. Observations have, however, shown that the non-significant difference can be attributed to the inability of the small stock to utilise the reed rather than to the grazing treatment itself. The significant difference between the control plot and the midsummer (average mass/plant and height) and the early winter and autumn treatments (both average mass/plant and density/10 m^2) can similarly be attributed to experimental error rather than to treatment effects.

Cattle-grazing experiment

Three of the five treatments (autumn, early winter and late winter) showed no significant difference to the control plot as far as the different determinations are concerned. The non-significant differences could, as in the case of the sheep-grazing experiment, largely be attributed to the fact that the animals did not utilise the reed to the expected extent. It was apparent that the reed could not support the calculated number of animals for the expected 14 days of occupation. Observations proved that the reed was greener during the remaining seasons (early and midsummer) and the animals were consequently able to utilise the reed to a considerable extent. The result was therefore a significant difference between these two treatments and the control plot.

It became apparent during the study that especially the small stock were unable to utilise the reed when it is full-grown. The large stock were able to utilise the reed to a certain extent when new growth was present but were also unable to utilise it during the relatively dry seasons. One can conclude that it is necessary to cut the reed in order to make it available to the animal. This could, however, not give an answer as to the frequency of cutting for example, every year, every second or every third year.

The results of this study are, however, rendered unreliable owing to a number of practical problems encountered during the study as well as a number of experimental errors. The latter are mainly the result of faulty experimental planning and layout. It is therefore difficult to come to a definite conclusion as to which treatment has the least influence on the reed population.

The value of reed as a potential supply of fodder for animals together with its primary function, *viz* stabilisation of soil conservation works should never be underestimated. The direct utilisation of reed without rejuvenation of the stand is, especially with small stock, not practical. Alternative methods of utilisation of the reed, e.g. harvesting and processing of the reed, should therefore be investigated. Together with these investigations the best frequency of harvesting of the stand without hampering the primary purpose of the reed, should also be investigated.

Central grassveld areas

VELD

POTENTIAL STUDIES

D.5461/36/1/2: EVALUATION OF THE PRODUCTION POTENTIAL OF ACACIA/GRASS COMMUNITY OF THE CENTRAL GRASSVELD OF THE EASTERN CAPE. 1979-1982

A.J. Aucamp

An investigation was undertaken to determine the relation between bush density and animal production per hectare as well as between bush density and profitability per hectare. Boer goat farming was found to be more profitable in the short term than beef ranching. The best long-term strategy is a combination of goats and cattle in an integrated animal production system. Such an integrated system is approximately three times as profitable as a pure beef production system. A prerequisite for implementation of such a system is that stocking rates of cattle must be set according to the condition of the herbaceous vegetation and those of goats according to the condition of the woody vegetation.

VELD

POTENTIAL STUDIES

D.5461/36/1/3: EFFECT OF *ACACIA KARROO* ON FORAGE PRODUCTION IN THE CENTRAL GRASSVELD AREAS OF THE EASTERN CAPE. 1977-1983

A.J. Aucamp, J.E. Danckwerts, W.R. Teague and J.J. Venter

An investigation was undertaken to determine the relationship between tree density and grass production, tree density and overall feed production and between tree density and animal production. It was found that grass production does not decrease linearly with increasing tree densities. Grass production is not affected up to a density of 297 tree equivalents per hectare. Maximum feed production (grass plus bush) was achieved at 847 tree equivalents per hectare. The maximum red meat production that could be achieved by using a combination of Boer Goats and cattle was estimated by extrapolation to be at a tree density of 2 600 tree equivalents per hectare, while the maximum gross margin would have been at 1 620 tree equivalents per hectare.

AGRICULTURAL PRODUCTION ECONOMICS RESEARCH

Macro research economics

STRUCTURAL STUDIES

PRODUCTION ECONOMY

J. van Zyl: THE ECONOMIC FEASIBILITY OF PROPOSED TENURIAL PATTERNS ON THE UMFOLOZI FLATS.

(Research project PE.5612/48/2/2)
M.Sc.(Agric.) thesis, University of Pretoria
Supervisor: Prof. J.A. Groenewald

Alternative utilisation possibilities of vacant State land in the Umfolozi Flats were investigated. Competition exists between small farmers, the Co-op. (U.C.S.P.) and private companies for the usage of the State land. The small farmers allege that their existing units are not economically viable, whereas the Co-op.

wants to expand its farming operations.

The analytical approach was used to research the economics of sugar cane farming under conditions of periodic flood damage, the size of a viable unit, alternative tenure forms, and ways to reduce flood damage.

The Umfolozi Flats are very suitable for sugar cane production and the Co-op. plays an important role in the processing of sugar cane and supply of infrastructure.

Three groups of producers (settlement farmers, Co-op. and 'other farmers') were separately analysed in the Umfolozi Flats. The average size of settlement farms is less than that of the 'other farmers', but yields per unit of area are higher and more stable. Yields and the stability thereof obtained by the Co-op. are lower than yields obtained by the 'other farmers'.

Advantages as well as disadvantages of scale apply to the Umfolozi Flats. The most stable net income stream is found on farms of between 70 ha and 80 ha. A farm size of 80 ha will probably be able to provide the average needs of a family without affecting the net worth of the farming operation.

Renting land is an alternative form of tenure and to be successful at long-term crop cultivation, such as sugar cane production, the lessee must be compensated for improvements made, and such compensation should be specified in the lease contract.

Average net cash flow with share-cropping is somewhat higher than with fixed rent, irrespective of farm size. The purchase alternative consistently yields the lowest average net cash flow with the smallest stability. Differences in net cash flow and the stability thereof are relatively small and probably insignificant between share-cropping, fixed rent, and purchase. A choice between the three must also give consideration to other advantages and disadvantages associated with each tenure farm.

Flood damage was identified as a pure risk and therefore insurable. An insurance pool with a central stabilisation fund has particular implementation possibilities in the Umfolozi Flats. Net cash flow and the stability thereof are higher with an insured crop, because income is supplemented by insurance payments in years when flood damage occurs.

Structural flood control measures such as canalisation and flood storage can be justified economically. The highest net benefit is gained at a channel width of 65 m and a flood storage capacity of $1{,}3 \times 10^8$ m^3, respectively. The construction of a flood control dam in the near future is improbable. On the other hand, an enlarged channel may be completed within a very short time.

ENTREPRENEUR DEVELOPMENT

PROGRAMMED EXTENSION: WEEDS

Central grassveld areas

NASSELLA

PERSUASION

D.6662/39/1/1: PROGRAMME TO COMBAT TUSSOCK GRASS (*NASSELLA TRICHOTOMA*) AND *STIPA TENNUISSIMA* IN THE EXTENSION WARD OF BARKLY EAST. 1972-1984

J.C. Scheltema

After the grass *Stipa trichotoma* (nassella) had been identified on farms in the Barkly East magisterial district, the Extension Officer launched a persuasion campaign in conjunction with the Nassella Action Committee, who operated under the auspices of the Barkly East Farmers' Union, and the local Soil Conservation Committee to control this undesirable invader.

The farmers were excellently motivated and instructed and they tackled this campaign as a mutual problem. A nassella eradication fund was raised, various methods of eradication applied and experiments conducted to determine the most suitable herbicide.

By means of this joint effort they managed to control the nassella effectively except on two badly infested farms where the Department of Agriculture rendered assistance since 1980 by means of departmental gangs.

AGRICULTURAL ENGINEERING SERVICES

Irrigation and drainage engineering

DRAINAGE

EVALUATION

AL-MI.55/1: EVALUATION OF THE MODERN DRAINAGE THEORY FOR SUBSURFACE DRAINAGE SYSTEMS IN THE WINTER RAINFALL REGION. 1977-1982

R.P. Perold

In this project

(1) Applicability of the drainage theory for practical design purposes in the Winter Rainfall Region was investigated
(2) Theory and design procedures were developed further and procedures facilitated
(3) Apparatus required for drainage investigations was improved or developed

The applicability of drainage theory

The applicability of drainage theory in practice was investigated and the suitability of designs judged by the results of a field investigation and the evaluation of existing systems by means of inspection and enquiry.

DRAINAGE

Field investigation at Lutzville

The subsurface potential field in the vicinity of an existing drain, about 2 m deep, was determined under various conditions. This was done by means of a set of 25 piezometers, installed at depths varying from about 1,5 to 2,4 m and at distances of 0,75; 1,5; 3 and 6 m from the drain.

A vacuum apparatus was constructed which could maintain a constant suction on all the piezometers so that the water columns could be sucked up to a convenient level that could be read in glass tubes. Details of this apparatus are described, as well as particulars of problems which occurred with the piezometers and improvements effected.

Satisfactory potential nets could be determined with the improved system. These indicated that a deep, relatively permeable layer served as a good conductor in which flow could pass underneath the drain should the water table on one side be low and the other side having been irrigated. The indications are that an increased drain depth (by 0,5 m) would have improved the drainage efficiency considerably. The potential variation during the course of a heavy irrigation and the subsequent drainage cycle was investigated.

From the results of this experiment the permeability in various portions of the instrumented area could be judged. It was found that the values so obtained appear to be reasonably in line, with values determined near by by means of the bore hole and piezometer methods. It was found that these field permeability results were in the order of 50 times larger than those obtained in the laboratory on disturbed samples of the silt material at the site. This shows the danger of basing design on such tests in the case of silt or clay soils.

The drainable pore space could be estimated from the rate of subsidence of the water table as noted from the potential nets. A very low value of about 1 % was found and this accounted for the rapid saturation of the soil and the later rapid drop of the water table. It appears that drainage occurs mainly in a limited number of macropores, whereas the balance of the soil might remain practically saturated. This is thought to be the reason why the long past history of reclamation attempts at the particular site has not been very effective, as the time of saturation of the complete soil body might have been insufficient for good diffusion of salts from the micro- to the macropores.

The results of this experiment indicated that flow nets, as determined in the field, could be used effectively to give a good picture of drainage course and that the basic theoretical principles of ground water flow can be applied with confidence for design, provided that the hydraulic properties of the terrain are known precisely. In practice, local variations from assumed values may, however, exert a large influence and a very intensive investigation may be required in some instances. In the case of the experimental site, investigation of the soil profile to at least a depth of 3 m would be desirable for drainage design, as well as piezometric determination of permeability at these depths. This would require more specialised apparatus than is normally available in the field.

Evaluation of existing systems

A number of farms were visited and the effectiveness of the existing drainage systems evaluated by inspection and enquiry. In one case a water table study was made. Most of the systems were reasonably effective and over-design could not be determined specifically. A few cases occurred where relatively large local inflows had to be coped for by increasing the pipe size.

It appears that the bank region next to a river is frequently relatively dense, possibly due to the settling in of silt and clay amongst dense vegetation in this area during floods. This causes a barrier which prevents good subsurface drainage to the river, even though its bed might be relatively deep below the surrounding terrain.

Conclusions

Designs, as being done today, appear to give satisfactory results in general. The Lutzville experiment indicated that modern drainage theory can be used with confidence if the subsurface conditions are completely known. Unfortunately such conditions are sometimes very variable, especially in the case of alluvial deposits, and in such cases the designer might have to base his design on previous experience in the area.

It is recommended that permeability tests should be done more regularly and that, where deep permeable layers may occur, an investigation, e.g. by means of jetting, should be made and the farmer requested to dig at least one deep test pit.

When an official starts design work in a new region, it would be desirable that he should investigate a number of cases of differing nature intensively during his first year. In this he should be assisted on occasion

by an engineer who has the necessary apparatus, e.g. for deep investigations, at his disposal. A special investigation unit should be available in the region for this purpose.

DRAINAGE

EVALUATION

AL-MI.55/2: EVALUATION OF FILTERS AND ENVELOPES FOR DRAIN TUBES. 1978-1982

R.P. Perold

Filters are used to prevent particle migration into drain pipes whereas the function of an envelope is to reduce entry resistance, to the inflow of drainage water.

Envelopes

Entry resistance

The entry resistance, a, is a dimensionless expression of the additional head loss, H_w, caused by the concentration of flow towards the openings in the pipe in the medium surrounding a drain pipe, above the head loss that would have occurred had the pipe been completely pervious to inflow. By plotting the piezometric head distribution, as found to occur in the medium surrounding a pipe, against the logarithm of the radius, a straight line course is found at larger radii where the concentration effect is not as yet noticeable. Extrapolation of this line to the pipe wall enables one to determine the additional head loss H_w, owing to concentration.

Graphic determination of entry loss

By obeying the law expressing the change in pattern of a flow net with radius for radial flow, flow nets can be drawn for simple cases, e.g. for flow towards a clay pipe drain with crack openings between the pipes. From these figures the radial head distribution can be plotted and the entry loss found as indicated above. This was done for a few cases. The values so determined appear to be high, roughly double as high as those experimentally determined.

Experimental determination of entry loss

A cylindrical tank containing sand and with drainage pipes placed vertically in the centre was used. Piezometers were installed in the sand layer at varying radii. This apparatus was generally similar to that used by Wesseling & Homma (4), but differed in that a confined aquifer (completely filled with water) was used instead of an unconfined aquifer with a water table.

The values obtained appear to be of the same order as those obtained by Wesseling & Homma (the pipe types were different). The following values were obtained:

102 mm pitch fibre pipes with two rows 8 mm holes @ 76 mm c/c	0,4
100 mm clay pipes 300 mm long, 3 mm crack joints	0,29
97-110 mm corrugated plastic pipe	0,175
160 mm porous concrete pipe	0,10
100 mm special clay pipe	± 0

The last case above was a clay pipe round which 6 mm wide and deep channels had been formed longitudinally (with Masonite strips) and which was wrapped with Bidim filter cloth. A near perfect drain pipe, regarding entry loss, was thus obtained. Corrugated plastic tube enveloped in a layer of filter cloth will perform similarly.

Practical applications

Entry loss will only be of importance where pipes are placed directly in a soil which causes marked flow resistance. Where envelopes are used, entry loss is of no importance owing to the low velocities in the envelope. It is shown that where soil is enveloped in a medium (e.g. top soil) which has a permeability ten times that of the surrounding soil, the entry loss will be practically eliminated with pipe types as normally used.

A further advantage of using envelopes is that the effective diameter of the pipe is increased to practically that of the envelope. It is shown that the increase in flow thus obtained may be 50 % larger than that obtained without an envelope where a 150 mm pipe is placed in a 300 mm diameter envelope. "Open" envelopes with large pores (e.g. packed rock) can be used in cohesive soils which can bridge large openings without the danger of slumping into the holes.

In alluvial soils where flow may be concentrated in sand lenses, relatively open envelopes are advantageous in that such concentrated flow will be spread better longitudinally to the adjacent pipe. In the case of sandy soils such open envelopes should be covered with a layer of plastic on top. Such an envelope of 50 to 150 mm stones was found to be in a good condition after five years.

Filters

Filters may be required where soil particles may otherwise become dislodged and move into the envelope or pipe. Particles may move into an envelope by rolling action. Although particles may be transported by water in areas where high velocities occur, e.g. near openings in drain pipes, such instances can only rarely be expected. In cohesive soils filters will usually not be essential.

A filter should not be seen as a screen (a screen will eventually become blocked if it is effective), but rather as a supporting system, with supports sufficiently closely spaced to prevent movement of the upstream or higher lying particles. Filters also serve (by envelope effect) to reduce velocities at the point of entry from the soil.

Filters may be of the membrane or thick-layer types. In a membrane filter a fibre cloth (e.g. of acrylic material) is used as a support. If used directly on a pipe with high entry loss properties, it will not be very effective owing to its thinness and resultingly poor lateral conductivity. It should be either supported on an envelope or used directly on corrugated drain pipe where the surrounding soil is reasonably permeable.

Thick layer filters are usually constructed of locally available materials. Layered (Terzaghi) filters would be ideal but are not used owing to difficult construction and high cost. A thick layer of graded material is usually used. The USDA specifications ensure sufficient porosity as well as good supporting ability.

Locally, coal ash is commonly used as a filter material or for envelopes. A sample of such material, as used on a drainage system, was investigated. It was found that the grading was far from ideal, with large pores and a relatively high percentage of fines. It was also found that the fines could readily migrate through the medium, even due only to saturation. Such material should preferably be washed. Where systems using coal ash were inspected, serious trouble owing to particles washing into pipes was not apparent, however. Only in cases of badly mis-aligned clay pipes was such entry noticeable.

Root entry

Blocking of drains by roots can occur where a portion of a drain conducts drainage through a relatively dry area at times. A safeguard against this is to provide tight pipes over such sections with a local short drain next to it, which feeds into the main line at its lower end.

FLORA

BOTANY

BOTANY RESEARCH

Plant taxa

FLORA

TAXONOMY

PL.7111/01/1/2: FLORA OF SOUTHERN AFRICA: POACEAE-MELICEAE. 1979-1983
G.E. Gibbs-Russell

The genus *Melica* was first described by Linnaeus, and alone of all his grass genera has been unchanged in its interpretation to the present day. In Species Plantarum (1753), Linnaeus described three species in *Melica*, all from the Northern Hemisphere. The first southern African species were described by Thunberg in the Prodromus of 1794, where he assigned six species to the genus, but in Flora Capensis of 1823 he correctly moved four of these to *Ehrharta*, leaving in *Melica* the two species presently recognised. Additional species were described over the years by Lichtenstein (1817), Schrader (1821), Lehmann (1828), Nees (1841) and Stapf (1900 and 1910). By the time the comprehensive account in Flora Capensis was written at Kew, Stapf (1900) recognised six species. Following Stapf, Chippindall (1955) accounted for seven species, but gave keys only to the two Thunberg species, and implied doubt about the status of the other five.

In the present treatment, six species have been reduced to synonymy, so that now only two *Melica* species are recognised in southern Africa. They may be differentiated in the following way:

	M. racemosa	*M. decumbens*
Hairs on lemmas of bisexual florets	On margins only	On margins and on back
Hairs on lemmas of sterile florets	Absent	Present
Spikelet length	5-9 (-11) mm	10-15 mm

M. racemosa is a variable species that includes entities accepted as separate species in the past; *M. ovalis, M. bolusii, M. pumila* and *M. brevifolia*. Characters used to separate these taxa, such as culm length, leaf length, glume shape and length, and number of bisexual florets, vary independently and are not generally correlated. The reduction of bisexual florets to one appears to be related to hostile environments such as high altitudes and sea dunes. Specimens from Natal tend to have spikelets 9-11 mm long, overlapping into the size range of *M. decumbens*, and were included in that species by Gordon-Gray in the Flora of Natal (1972). These specimens should be assigned to *M. racemosa* because of the glabrous backs to the lemmas.

Its range is from the South-western Cape to Natal, Lesotho and the Eastern Orange Free State; it occurs rarely in the Eastern Transvaal. It grows among rocks on steep hill and mountain slopes, as well as in savanna and fynbos, at the edges of bush clumps and in grassland, and rarely between seaside dunes and in forest clearings.

M. decumbens is more uniform in appearance than *M. racemosa*, and only one species has been reduced to synonymy under it, *M. neesii* Stapf. *M. decumbens* has been known as "dronkgras" since the time of Thunberg, and is suspected of being poisonous to cattle, horses, and donkeys. Affected animals stagger as if intoxicated. *Ehrharta villosa*, a species from another tribe within the grass family, may be confused with *M. decumbens*. The species are easily distinguished by the presence of short awns at the tips of the lemmas in *E. villosa*, and the presence of congested sterile lemmas at the tip of the rhachilla in *Melica*.

The distribution of *M. decumbens* is centered in the Eastern Cape and extends into the Northern Cape, Orange Free State and Lesotho. It is known from the South-western Cape only from the type specimen of Thunberg. *M. decumbens* grows on hillsides, koppies and mountainsides, often among rocks or in the shade of trees; occasionally it occurs on roadsides or along railway lines.

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Vegetation

GRASSLAND

ANATOMY

PL.7112/02/1/7: GRASS IDENTIFICATION BY EPIDERMAL STRUCTURE FOR HERBIVORE FOOD STUDIES IN THE ANGIOSPERMAE. 1979-1983

R.P. Ellis

In recent years food preferences of herbivores have generally been determined by microhistological analysis of their faeces or rumen. This method is based on two basic principles, namely that the epidermis of grasses possesses diagnostic characteristics for specific identification, and that the epidermis is covered by an undigestible cuticle. In the past, the leaf blade, and specifically the abaxial epidermis, was mainly used as reference material in such studies. However, there exists some degree of uncertainty about the homogeneity of the entire epidermis of a given plant and the influence of the environment and age on the epidermal characteristics of a given species. An extensive study of the epidermis of grasses was undertaken to find solutions to some of these problems.

Brachiaria serrata, Eragrostis capensis and *Themeda triandra* were collected in different stages of development in different localities of southern Africa. Aerial parts were studied with both the light and scanning electron microscope. Both the abaxial and adaxial epidermis of the leaf blade, leaf sheath, parts of the inflorescence and the epidermis of the stem were examined. The distribution of the cuticle in the three different species was also studied. It was found that the epidermis of the rest of the grass plant did not necessarily agree in microscopic structure with the abaxial epidermis of the leaf blade. In some cases it was impossible to recognise certain organs by the epidermal characteristics of another, owing to differences between different parts and between the abaxial and adaxial epidermis of the same part of the plant. A variation in epidermal characteristics was found to occur in a single species over a large geographical distribution. In the case of the absence or presence of a characteristic, e.g. macrohairs and prickles or hooks, the identification of a species could be affected. However, the variable characteristics were mainly quantitative and did not affect the basic morphology of the epidermis. The variation within a single plant was therefore greater than the variation between different specimens of one species.

The distribution of the cuticle on a grass plant was found not to be uniform. Some plant parts were not covered by a continuous cuticle and immature organs which had not yet been exposed to the atmosphere, had no cuticle. The digestibility of different species and the digestibility between different plant organs of one species also differed. The digestibility of a species increased to a maximum during the growth season after which it decreased as the season progressed.

It was concluded that the epidermis of the whole plant must be examined and considered in a microhistological faecal analysis of herbivore diets. As the epidermal characteristics of a species may differ in different localities, it will be advisable to prepare reference material from the species of a certain habitat when doing a food preference study of animals in that area. The quantification of results is greatly influenced by the uneven distribution of the cuticle and differences in digestibility. The use of microhistological faecal or rumen analysis is valuable in qualitative food studies but quantitative analysis seems unreliable owing to many factors.

Valuable veld plants

OTHER USEFUL PLANTS

ETHNOBOTANY

PL.7136/26/1/2: OTHER USEFUL PLANTS: TSONGA USE OF INDIGENOUS SPECIES, PARTICULARLY MOPANI, FOR FUEL AND STRUCTURAL TIMBER. 1979-1984

M.J. Wells and C.A. Liengme

This study was undertaken because of concern at the deforestation taking place in heavily populated rural areas of the Transvaal.

The utilisation of wood for fuel and building timber was studied in a 13 000 ha area of Gazankulu, near Giyani. A well-wooded area with a wide variety of woody species present, was chosen to ensure that people were not limited in the amounts of wood that they could gather, and that they also had the opportunity to be selective.

Headloads of firewood brought in by eight of the 978 families present were monitored. The average size of the families was 7,1 persons, and their overall mean consumption of firewood was 14,9 kg per family per day (5 438,5 kg or 5,4 t/family/a). The annual demand for firewood in the study area is, therefore, approximately 5 300 t. Three species *Colophospermum mopane, Combretum apiculatum* and *Acacia nigrescens* made up 77,2 % by mass of the wood, with 34 other species accounting for the rest.

Living huts and storage huts, in the process of being built, were examined and found to contain mean volumes of 1,30 m^3 and 1,09 m^3 of wood, respectively. Using a conversion factor and applying it to the 89 living and 80 storage huts built in the area during the year, revealed an annual demand for 231 t of finished timber (averaging 230 kg per family). In all, some 21 000 poles were used. *Colophospermum mopane* accounted for 97,3 % of the wood used in living huts and 92,2 % of that used in storage huts.

The annual demand for firewood and finished building timber in the 13 000 ha study area is approximately 5 500 t, i.e. 423 kg/ha/a. Since annual wood production in the area may be approximately 600 kg/ha (Rutherford, 1978) sustained yield harvesting of wood may be possible if wood is gathered evenly over the whole area and if extra supplies are not collected for outside users (nearby town dwellers).

PLANT PRODUCTION PROMOTION/PLANTPRODUKSIE-BEVORDERING

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Bushveld areas/Bosveldgebiede

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GG.2111/20/11/1: The distribution and incidence of the grain sorghum stem borer, *Chilo partellus* on maize. 1984. J.M. du Toit

GG.2111/20/11/2: The ecology of the grain sorghum stem borer, *Chilo partellus* on maize. 1984. J.M. du Toit

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GG.2121/03/1/1: Determination of the temperature requirement of wheat. 1982. G.D. Joubert

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NUTRITION/VOEDING

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GG.2121/05/1/8: Effect of phosphate fertilisation on wheat in the summer rainfall region. 1983. W.H. Kilian

UPGRADING/VEREDELING

GG.2121/07/1/1: The evaluation of newly developed elite and imported winter and intermediate wheat lines. H.A. van Niekerk

GG.2121/07/1/2: The determination of breeding value of several imported characters of winter wheat with the aid of the North Carolina III design. 1976. H. Cerfonteyn

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GG.2121/07/2/3: The genetic control of photoperiod/temperature sensitivity of wheat. 1978. P.B. le Grange

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GG.2121/07/3/2: The influence of gamma rays on wheat gametophytes. 1976. H.A. van Niekerk

GG.2121/07/4/1: The evaluation of wheat germ plasm. 1981. I.B.J. Smit

GG.2121/07/4/2: The upkeep of unique wheat germ plasm. 1981. M. Streutker

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GG.2121/07/5/1: The quality evaluation of all newly developed wheat lines. 1976. H.A. van Niekerk

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PATHOLOGY/PATOLOGIE

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GG.2121/19/1/3: The influence of fertilisers and crop rotation on the occurrence of take-all (*Gaeumannomyces graminis* var. *tritici*) in irrigated wheat. 1983. E.M.C. Maas

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GG.2121/19/1/5: Chemical control of root disease in wheat. 1982. E.M. Smith

GG.2121/19/1/6: Observation on the occurrence of air-borne diseases of wheat in South Africa. 1980. Z.A. Pretorius

GG.2121/19/2/2: Collection, maintenance and classification of wheat stem rust biotypes (*Puccinia graminis* f. sp. *tritici*). 1980. J. le Roux

GG.2121/19/2/3: Collection, maintenance and classification of wheat leaf rust races (*Puccinia recondita* f. sp. *tritici*). 1980. Z.A. Pretorius

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GG.2121/20/1/3: Seed treatment with systemic insecticides for the chemical control of the Russian wheat aphid, *Diuraphis noxia*. 1980. P.A. Butts

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GG.2121/20/3/1: Survey of eelworm species in the wheat-producing areas. 1983. S. Storey

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GG.2121/30/4/2: The influence of stubble mulches on grain yield of wheat in the summer rainfall area. 1982. H.A. Smit

GG.2121/30/5/1: The control of wild oats in wheat by means of a maize/wheat production system in the summer rainfall area. 1982. H.A. Smit

GG.2121/30/6/1: The application of herbicides on different stages of wild oats in wheat in the winter rainfall area. 1982. H.A. Smit

GG.2121/30/6/3: Phytotoxicity of wild oats and grass herbicides in promising wheat lines and new wheat cultivars in the winter rainfall region. 1982. H.A. Smit

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GG.2121/30/8/1: The effect of wild oats competition on the grain yield of wheat in the Winter Rainfall Region. 1982. H.A. Smit

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GG.2121/53/1/1: Evaluation and refinement of routine quality analytical procedures on wheat. 1976. H.A. van Niekerk

GG.2121/53/1/2: Upkeep of a protein laboratory for applied quantitative protein analytical procedures of wheat. 1976. H.A. van Niekerk

GG.2121/53/1/3: The identification of wheat cultivars by means of prolamine electrophoreces profiles. 1980. H.A. van Niekerk

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GG.2122/07/1/1: The evaluation of elite newly developed and introduced cultivars. 1976. W.H.C. Struwig

GG.2122/07/2/1: The selection of meiotic stable breeding parents from advanced triticale lines. 1976. W.H.C. Struwig

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GG.2122/07/3/1: The evaluation of triticale germ plasm. 1981. I.B.J. Smit

GG.2122/07/3/2: The upkeep of unique triticale germ plasm. 1981. M. Streutker

GG.2122/07/3/3: The development of a computerised data base for unique triticale germ plasm. 1983. F.M. Thatcher

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GG.2123/05/1/1: Effect of nitrogen fertilisation on the production and quality of durum wheat under irrigation. 1982. W.H. Kilian

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GG.2123/07/1/1: The evaluation of elite newly developed and imported durum lines. 1976. H.A. van Niekerk

GG.2123/07/2/1: The evaluation of durum germ plasm. 1981. I.B.J. Smit

GG.2123/07/2/2: The upkeep of unique durum germ plasm. 1981. M. Streutker

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GG.2123/07/3/1: The quality evaluation of all newly developed durum lines. 1976. H.A. van Niekerk

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GG.2124/03/1/1: Determination of factors which cause black end coloration to barley in the winter rainfall area. 1982. E.J.G. Brand

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GG.2124/07/1/1: The breeding of barley and evaluation of elite newly developed and imported cultivars. 1976. P.B. le Grange

GG.2124/07/2/1: The evaluation of barley germ plasm. 1981. I.B.J. Smit

GG.2124/07/2/2: The upkeep of unique barley germ plasm. 1981. M. Streutker

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GG.2124/07/3/1: Quality evaluation of all new barley lines for brewing characteristics. 1976. H.A. van Niekerk

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GG.2124/30/1/1: Seed multiplication of elite barley lines and cultivars in the winter rainfall area. 1982. E.J.G. Brand

GG.2124/30/1/2: Seed multiplication of the elite barley lines and cultivars in the summer rainfall area. 1982. G.D. Joubert

GG.2124/30/2/1: Determination of the optimum planting date and sowing rate of barley cultivars in the winter rainfall area. 1983. E.J.G. Brand

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GG.2124/30/3/2: Phytotoxicity of wild oat herbicides on barley in the winter rainfall area. 1982. H.A. Smit

GG.2124/30/3/3: Phytotoxicity of herbicides on promising barley lines and new barley cultivars in the summer rainfall area. 1982. H.A. Smit

GG.2124/30/3/4: The determination of the apex development stages of barley for the safe application of hormone type herbicides in the summer rainfall area. 1982. H.A. Smit

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GG.2125/07/1/1: The evaluation of elite newly bred and imported rye lines. 1976. G.F. Marais

GG.2125/07/2/1: The evaluation of germ plasm. 1981. I.B.J. Smit

GG.2125/07/2/2: The upkeep of unique rye germ plasm. 1981. M. Streutker

GG.2125/07/2/3: The development of a computerised data base for unique rye germ plasm. 1983. F.M. Thatcher

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GG.2126/07/1/1: The evaluation of elite newly developed oat lines and introductions. 1976. M. Streutker

GG.2126/07/2/1: The evaluation of oat germ plasm. 1981. I.B.J. Smit

GG.2126/07/2/2: The upkeep of unique oat germ plasm. 1981. M. Streutker

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GG.2126/30/1/2: Seed multiplication of elite oat lines in the summer rainfall area. 1982. G.D. Joubert

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GG.2126/30/2/2: Determination of optimum planting date and sowing rate of oat cultivars in the summer rainfall area. 1982. G.D. Joubert

GG.2126/30/3/1: The determination of the safe apex development stages of oat for the application of hormone type herbicides in the summer rainfall area. 1982. H.A. Smit

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GG.2131/03/2/1: The influence of varying temperatures on the gynophore and pod set of groundnuts. 1983. J. Dreyer

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GG.2131/05/1/1: NPK fertiliser studies with groundnuts. 1983. H.L. Loubser

PATHOLOGY/PATOLOGIE

GG.2131/19/3/1: The influence of groundnut root and pod exudates on *Chalara elegans*. 1984. J.R. Anderson

GG.2131/19/3/2: The influence of groundnut rhizosphere micro-organisms in controlling/stimulating *Chalara elegans* infestation. 1984. J.R. Anderson

GG.2131/19/3/3: Interactions between *Chalara elegans* and saprophytic or ecto-parasitic nematodes in the dissemination of the disease (black hull) on groundnuts. 1984. J.R. Anderson

GG.2131/19/3/4: Method of entry of *Chalara elegans* into groundnut tissue. 1984. J.R. Anderson

GG.2131/19/3/5: Development of reproducible and accurate method for enumerating spores of *Chalara elegans* in groundnuts, soils and plant debris. 1984. J.R. Anderson

GG.2131/19/3/6: Laboratory studies on the nutritional requirements and biochemical pathways of *Chalara elegans* as found on groundnuts. 1984. J.R. Anderson

GG.2131/19/3/7: Laboratory and greenhouse preliminary screens on groundnuts for biocides active against *Chalara elegans*. 1984. J.R. Anderson

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GG.2131/30/4/1: Determining the effect of nut grass, *Cyperus* spp. on the yield of groundnuts. 1982. A.P.J. de Beer

GG.2131/30/4/2: The effect of Dimitramine herbicide on the growth and development of the runner type groundnuts. 1983. A.P.J. de Beer

SUNFLOWERS/SONNEBLOMME

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GG.2132/03/1/1: Study on effect of environmental factors on growth, development and yield of sunflower. 1982. R.N. de Vos

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GG.2132/05/1/1: The nitrogen, phosphorus and potassium requirements of sunflowers. 1981. H.L. Loubser

GG.2132/05/1/2: The response of sunflowers to different rates of nitrogen and phosphorus as influenced by liming. 1981. H.L. Loubser

GG.2132/05/1/3: The evaluation of leaf analysis as a diagnostic technique in sunflower nutrition. 1981. H.L. Loubser

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GG.2132/07/1/3: The breeding of sunflower A/B lines and composites for utilisation in hybrid breeding. 1974. W.J. Vermeulen

GG.2132/07/1/4: Genetic studies on the relationships between isogenic-branched and -unbranched sunflower lines. 1983. S.J. Poggenpoel

CROP SCIENCE/GEWASKUNDE

GG.2132/30/1/2: The ability of sunflower cultivars to compensate for low plant populations. 1983. H.L. Loubser

GG.2132/30/1/3: The ability of sunflower cultivars and breeding lines to emerge at high temperatures. 1983. H.L. Loubser

GG.2132/30/1/4: Reaction of sunflower cultivars on varying levels of soil acidity. 1982. J. Chapman

SOYBEANS/SOJABONE

PHYSIOLOGY/FISIOLOGIE

GG.2133/03/1/1: The effect of planting date on the response of soybean cultivars at different plant populations. 1983. J. Chapman

NUTRITION/VOEDING

GG.2133/05/1/1: The interaction of lime on nitrogen, phosphorus and potassium fertilisation on soybeans. 1983. J. Chapman

GG.2133/05/1/2: The determination of critical values for soil phosphorus with soybeans. 1983. J. Chapman

UPGRADING/VEREDELING

GG.2133/07/1/1: Evaluation of soybean lines/introductions for use as commercial cultivars and/or as parents in a breeding programme. 1983. T.E.M. Odendaal

GG.2133/07/1/2: The selection and generation of segregating material. 1984. T.E.M. Odendaal

CROP SCIENCE/GEWASKUNDE

GG.2133/30/1/4: Genotype x environment interactions on yield tests and the application to a soybean breeding programme. 1984. T.E.M. Odendaal

DRY BEANS/DROëBONE

NUTRITION/VOEDING

GG.2134/05/1/1: The effect of nitrogen application levels at different growth stages of dry beans. 1983. A.J. Liebenberg

UPGRADING/VEREDELING

GG.2134/07/1/3: The breeding of dry beans for the packaging trade. 1983. B.R. Edington

CROP SCIENCE/GEWASKUNDE

GG.2134/30/1/2: The determination of the compensation ability of dry bean cultivars under varying plant densities. 1983. A.J. Liebenberg

GG.2134/30/1/3: The evaluation of dry bean cultivars and breeding lines for drought resistance. 1983. A.J. Liebenberg

GG.2134/30/1/4: The evaluation of the International Bean Yield and Adaptation Nursery (IBYAN) of CIAT. 1983. A.J. Liebenberg

GG.2134/30/1/5: The evaluation of the International Bean Rust Nursery (IBRN) of CIAT. 1983. A.J. Liebenberg

GG.2134/30/1/6: Effect of temperature on the vegetative and reproductive development of some South African dry bean (*Phaseolus vulgaris* L) cultivars. 1983. E.D. Lloyd

GG.2134/30/1/7: Response of bean cultivars on different soil acidity levels to determine aluminium tolerance. 1982. J. Chapman

GG.2134/30/1/8: Effect of herbicides on the growth and development of different dry bean (*Phaseolus vulgaris*) cultivars. 1983. A.P.J. de Beer

GG.2134/30/2/1: The influence of planting date on dry bean cultivars under different soil moisture levels. 1983. A.J. Liebenberg

Other agronomic crops/Ander akkerbougewasse

COTTON/KATOEN

NUTRITION/VOEDING

TK.2141/05/1/1: Response of cotton to nitrogen application with petiole analyses as a diagnostic aid. 1980. M.C. Dippenaar

TK.2141/05/1/2: Long-term NPK fertiliser study with cotton. 1972. M.C. Dippenaar

TK.2141/05/1/3: Influence of mutual relation among nutrient elements in the soil and in cotton plants on the yield potential. 1983. N.J.J. Combrink

TK.2141/05/1/4: Reaction of cotton to K:Ca:B ratios in pot experiments. 1983. N.J.J. Combrink

UPGRADING/VEREDELING

TK.2141/07/1/1: Cotton breeding and selection. 1974. H.G. van Heerden

TK.2141/07/1/2: Introduction of cotton-breeding lines and cultivars from abroad. 1974. H.G. van Heerden

TK.2141/07/1/3: Back crossings with cotton. 1963. H.G. van Heerden

TK.2141/07/2/1: Evaluation of cotton-breeding lines. 1960. H.G. van Heerden

TK.2141/07/2/2: National cotton cultivar trials. 1975. H.G. van Heerden

PESTS/PLAE

TK.2141/20/1/1: Control of nematodes in cotton. 1982. R.J. van Wyk

TK.2141/20/1/2: Survey and identification of parasitic nematodes in different cotton-producing areas. 1982. G.C. Prinsloo

TK.2141/20/2/1: Factors which affect the control of *Tetranychus cinnabarinus* with local systemic miticides. 1983. M.F. Herholdt

CROP SCIENCE/GEWASKUNDE

TK.2141/30/1/1: Application of growth regulators on cotton. 1981. M.C. Dippenaar

TK.2141/30/2/1: Chemical defoliation of cotton. 1982. M.C. Dippenaar

WATER REQUIREMENTS/WATERBEHOEFTES

TK.2141/31/1/1: Influence of moisture deficits during different growth stages. 1977. W.J.J. Roux

TK.2141/31/1/2: Effect of moisture deficits on different cotton cultivars and breeding lines. 1982. M.C. Dippenaar

TK.2141/31/2/1: Irrigation practices for establishing seedlings. 1976. W.J.J. Roux

TOBACCO/TABAK

NUTRITION/VOEDING

TK.2142/05/1/1: Nitrogen indices for and nitrogen supply of the Arcadia soil series for tobacco. 1972. H.J. Boshoff

TK.2142/05/1/2: Influence of different sources of nitrogen on the yield and quality of flue-cured tobacco. 1981. H.J. Boshoff

TK.2142/05/1/3: Trace-element nutrition of tobacco. 1973. H.J. Boshoff

TK.2142/05/1/4: Relationship between nutrient element status of soils and the yield and composition of tobacco. 1973. G.L. le M. Passanah

TK.2142/05/1/5: Chlorine in the soil, irrigation water and tobacco in the Hartebeespoort-Crocodile River irrigation area. 1979. F.J. Shawe

TK.2142/05/1/6: Potassium nutrition of tobacco. 1980. H.J. Boshoff

TK.2142/05/1/7: Magnesium nutrition of tobacco. 1980. H.J. Boshoff

TK.2142/05/1/8: Determination of lime requirement for tobacco soils. 1983. E.A. Davies

UPGRADING/VEREDELING

TK.2142/07/1/1: Determination of breeding value of flue-cured tobacco. 1964. M.P. Lamprecht

TK.2142/07/1/2: Determination of breeding value of dark air-cured tobacco. 1964. A.M. Esterhuizen

TK.2142/07/1/3: Determination of breeding value of light air-cured tobacco. 1967. A.P.F. Cornelissen

TK.2142/07/1/4: Determination of breeding value of burley tobacco. 1969. A. van der Spoel

TK.2142/07/1/5: Determination of breeding value of Oriental tobacco. 1969. M.P. Lamprecht

TK.2142/07/1/6: Utilisation of haploid plants in tobacco breeding. 1976. A. van der Spoel

TK.2142/07/1/7: Inbreeding of the male sterility factor in some *Nicotiana tabacum* cultivars. 1956. A.P.F. Cornelissen

TK.2142/07/1/8: Breeding of *Nicotiana tabacum* cultivars resistant to diseases. 1952. M.P. Lamprecht

TK.2142/07/1/9: Breeding of *Nicotiana tabacum* cultivars resistant to root knot nematodes. 1956. A.P.F. Cornelissen

TK.2142/07/1/10: Cytogenetic study of the *N. tabacum* x *N. rustica* hybrid. 1981. A. van der Spoel

TK.2142/07/1/11: Utilisation of *N. repanda* as source of root knot and disease resistance. 1981. A.M. Esterhuizen

TK.2142/07/2/1: Evaluation of flue-cured tobacco-breeding lines. 1966. M.P. Lamprecht

TK.2142/07/2/2: Evaluation of dark air-cured tobacco-breeding lines. 1966. A.M. Esterhuizen

TK.2142/07/2/3: Evaluation of light air-cured tobacco-breeding lines. 1966. A.P.F. Cornelissen

TK.2142/07/2/4: Evaluation of burley tobacco-breeding lines. 1966. A. van der Spoel

TK.2142/07/2/5: Evaluation of Oriental tobacco-breeding lines. 1958. W.J.C. van der Merwe

PATHOLOGY/PATOLOGIE

TK.2142/19/1/1: Interaction between *Phytophthora nicotianae* var. nicotianae and other soil inhabiting organisms in tobacco soils. 1973. G.C. Prinsloo

TK.2142/19/1/2: Influence of crop rotation on the black shank organism of tobacco. 1977. D.A. de Villiers

TK.2142/19/1/3: Chemical control of black shank in tobacco. 1980. G.C. Prinsloo

TK.2142/19/1/4: Alternative hosts of the black root rot organism of tobacco. 1980. D.A. de Villiers

TK.2142/19/1/5: Chemical control of black root rot in tobacco. 1980. G.C. Prinsloo

TK.2142/19/1/6: Involvement of *Fusarium* in the black shank complex on tobacco. 1983. M.C. Engelbrecht

TK.2142/19/2/1: Tomato spotted wilt in tobacco. 1981. L.L. Vorster

TK.2142/19/2/2: Potato virus Y in tobacco. 1981. L.L. Vorster

TK.2142/19/2/3: Bushy top disease of tobacco. 1981. R.J. van Wyk

PESTS/PLAE

TK.2142/20/1/1: Chemical control of the cigarette beetle in tobacco warehouses. 1969. E.G. Eulitz

TK.2142/20/1/2: Effectiveness of chemical control agents applied on different surface-covering materials for the control of cigarette beetles. 1974. E.G. Eulitz

TK.2141/20/1/3: Chemical control of bollworms on tobacco. 1973. E.G. Eulitz

TK.2141/20/1/4: Chemical control of aphids on tobacco. 1980. E.G. Eulitz

TK.2142/20/2/1: Control of nematodes in tobacco. 1961. R.J. van Wyk

TK.2142/20/2/2: Fluctuation of nematode population in different soil types. 1978. S.M. Claassen

TK.2142/20/2/3: Survey and identification of parasitic nematodes in different tobacco-producing areas. 1981. S.M. Claassen

TK.2142/20/2/4: Determination of threshold levels and infestation techniques for different soil types. 1981. S.M. Claassen

CHEMICAL CONTROL/CHEMIESE BEHEER

TK.2142/21/1/1: Chemical weed control in flue-cured tobacco plantings. 1968. M.P. Lamprecht

TK.2142/21/1/2: Chemical weed control in Oriental tobacco plantings. 1980. W.J.C. van der Merwe

CROP SCIENCE/GEWASKUNDE

TK.2142/30/1/1: Spacing and topping of flue-cured tobacco. 1966. M.P. Lamprecht

TK.2142/30/1/2: Spacing and topping of dark air-cured tobacco. 1966. M.P. Lamprecht

TK.2142/30/1/3: Spacing and topping of light air-cured tobacco. 1966. M.P. Lamprecht

TK.2142/30/1/4: Spacing and topping of burley tobacco. 1966. M.P. Lamprecht

TK.2142/30/1/5: Spacing and topping of Oriental tobacco. 1966. W.J.C. van der Merwe

TK.2142/30/1/6: Chemical control of suckers on tobacco. 1968. M.P. Lamprecht

TK.2142/30/1/7: Cultivation of tobacco directly following wheat under irrigation. 1976. M.P. Lamprecht

WATER REQUIREMENTS/WATERBEHOEFTES

TK.2142/31/1/1: Influence of flood and sprinkle irrigation on the yield and quality of flue-cured tobacco. 1968. W.J.J. Roux

TK.2142/31/1/2: Irrigation practices for establishment of seedlings. 1976. W.J.J. Roux

TECHNOLOGY/TEGNOLOGIE

TK.2142/52/1/1: Packing methods for the bulk handling and curing of flue-cured tobacco. 1975. J.G. Nel

TK.2142/52/1/2: Yield losses in the field during reaping, curing and grading of flue-cured tobacco. 1979. J.G. Nel

TK.2142/52/1/3: Curing of air-cured tobacco. 1981. J.G. Nel

TK.2142/52/1/4: Fermentation of air-cured tobacco. 1981. J.G. Nel

CHEMISTRY/CHEMIE

TK.2142/53/1/1: Factors responsible for slick or putty tobacco. 1978. J.G. Nel

TK.2142/53/1/2: Factors responsible for red-sponged tobacco. 1978. J.G. Nel

TK.2142/53/1/3: Factors responsible for flat leaf and grain in flue-cured tobacco. 1981. J.G. Nel

TK.2142/53/2/1: Determination of individual alkaloids in tobacco. 1981. J.G. Nel

TK.2142/53/2/2: Nornicotine status of flue-cured tobacco-breeding lines. 1981. J.G. Nel

TK.2142/53/2/3: Chemical changes during growth and curing of flue-cured tobacco. 1976. J.G. Nel

TK.2142/53/2/4: Physical and chemical characteristics of tobacco grades. 1978. J.G. Nel

TK.2142/53/3/1: Residues of insecticides in tobacco. 1969. E.G. Eulitz

TK.2142/53/3/2: Residues of fungicides in tobacco. 1969. E.G. Eulitz

SUNDRY AGRONOMIC CROPS/DIVERSE AKKERBOUGEWASSE

CROP SCIENCE/GEWASKUNDE

GG.2143/30/1/1: Introduction of rice-breeding material. 1980. J.J. Coetzee

GG.2143/30/1/2: Evaluation of cultivars for agricultural value and adaptability. 1980. J.J. Coetzee

CHICORY/SIGOREI

NUTRITION/VOEDING

D.2144/05/1/1: The fertilisation of chicory on an Oakleaf Limpopo. 1981. R.S. Marr

UPGRADING/VEREDELING

D.2144/07/1/1: The selection of chicory. 1975. R.S. Marr

CROP SCIENCE/GEWASKUNDE

D.2144/30/1/1: Chicory seed production. 1975. R.S. Marr

D.2144/30/1/2: The chemical control of weeds in chicory. 1975. R.S. Marr

D.2144/30/1/3: Planting and harvesting data for chicory on an Oakleaf Limpopo. 1980. R.S. Marr

D.2144/30/1/4: The influence of preceding crops on the yield of chicory. 1980. R.S. Marr

D.2144/30/1/5: The evaluation of chicory cultivars. 1975. R.S. Marr

HORTICULTURE RESEARCH/TUINBOUNAVORSING

Tuber crops/Knolgewasse

POTATOES/AARTAPPELS

PHYSIOLOGY/FISIOLOGIE

TB.2411/03/1/1: The influence of calcium on the cell wall and cell structure of potato tubers. 1983. Marianne W. Venter

TB.2411/03/2/1: *In vitro* storage techniques of disease-free mother material of potatoes. 1983. J.L.F. Dutrieux

TB.2411/03/2/4: Anther culture as a technique in the upgrading of potatoes. 1983. M.H. Crespo

TB.2411/03/3/1: Tolerance of potato cultivars to pre-emergence treatment with herbicides. 1978. B.J. Pieterse

NUTRITION/VOEDING

TB.2411/05/1/6: Influence of calcium on potatoes. 1984. M.W. Venter

UPGRADING/VEREDELING

TB.2411/07/1/2: Genetic studies in order to broaden the genetic base of potato breeding. 1974. A.F. Visser

TB.2411/07/2/1: Anther culture as technique in the upgrading of potatoes. 1983. M.H. Crespo

PATHOLOGY/PATOLOGIE

TB.2411/19/3/8: Potato virus Y in potatoes, identification and characterisation of strains. 1983. G.J. Thompson

PESTS/PLAE

TB.2411/20/1/2: Bio-ecological study of the potato snout beetle. 1984. J.M.I. Donaldson

CROP SCIENCE/GEWASKUNDE

TB.2411/30/1/1: Potato cultivar evaluation in the Winter Rainfall Region. 1973. A. Agenbag

TB.2411/30/2/12: An investigation into the effective utilisation of seed potatoes. 1983. B.J. Pieterse

Vegetables/Groente

ONIONS/UIE

UPGRADING/VEREDELING

TB.2422/07/1/2: The development of F1-hybrid onions in South Africa. 1983. J.J.B. van Zijl

PROTEAS

PATHOLOGY/PATOLOGIE

TB.2422/19/1/1: Studies of *Pyrenochaeta terrestris*, the pink root pathogen of onions. 1983. J.F. Ferreira

ROOT CROP VEGETABLES/WORTELAGTIGE GROENTE

CROP SCIENCE/GEWASKUNDE

TB.2424/30/2/1: Root crop vegetables: the influence of spacing on sweet potato production. 1983. C.P. du Plooy

LEGUME VEGETABLES/PEULGROENTE

PHYSIOLOGY/FISIOLOGIE

TB.2425/03/1/1: An evaluation of the efficiency of herbicides on green beans. 1981. P.F. Nortjé

TB.2425/03/1/2: Evaluation of herbicides for phytotoxicity on green bean cultivars. 1981. P.F. Nortjé

PATHOLOGY/PATOLOGIE

TB.2425/19/1/2: Legume vegetables: a study of common blight of green beans. 1984. B.H. Boelema

VINE CROPS/RANKGEWASSE

PHYSIOLOGY/FISIOLOGIE

TB.2426/03/1/1: Weed control studies in pumpkin and squashes. 1982. P.F. Nortjé

SUNDRY VEGETABLES/DIVERSE GROENTE

PHYSIOLOGY/FISIOLOGIE

TB.2427/03/1/1: Sundry vegetables: chemical weed control studies. 1981. P.F. Nortjé

CROP SCIENCE/GEWASKUNDE

TB.2427/30/1/2: Sundry vegetables: cultivation studies with lettuce. 1983. C.P. du Plooy

Flowers and ornamental plants/Blomme en sierplante

PROTEAS

PHYSIOLOGY/FISIOLOGIE

TB.2431/03/1/1: Prevention and control of physiological leaf browning of protea. 1984. J.A. Brink

CROP SCIENCE/GEWASKUNDE

TB.2431/30/2/2: Reproduction of proteas by means of slips. 1978. G.J. Brits

BULB FLOWER CROPS/BOLBLOMGEWASSE

PHYSIOLOGY/FISIOLOGIE

TB.2432/03/1/1: Embryo culture studies on bulb flower crops: *Gladiolus*. 1983. J.G.S. Janse van Rensburg

TB.2432/03/1/2: Embryo culture studies on bulb flower crops: *Ornithogalum*. 1984. Bela M. Vcelar

TB.2432/03/1/4: Rapid multiplication of bulb flower crops: *Ornithogalum*. 1983. J.L.F. Dutrieux

TB.2432/03/1/5: Rapid multiplication of bulb flower crops, *Lachenalia* sp. by means of tissue culture. 1982. J.G. Janse van Rensburg

TB.2432/03/1/6: Rapid multiplication of bulb flower crops, *Gladiolus* by means of tissue culture techniques. 1983. J.L.F. Dutrieux

PATHOLOGY/PATOLOGIE

TB.2432/19/1/2: Virus elimination by means of chemotherapy and meristem culture in bulb flower crops: *Ornithogalum*. 1984. Bela M. Vcelar

TB.2432/19/2/1: Bulb flower crops: study of *Uromyces transversalis* on *Gladiolus*. 1984. J.F. Ferreira

TB.2432/19/2/3: Bulb flower crops: chemical control of *Uromyces transversalis* on *Gladiolus*. 1984. J.F. Ferreira

CUT FLOWERS AND POT PLANTS/SNYBLOMME EN POTPLANTE

CROP SCIENCE/GEWASKUNDE

TB.2433/30/1/2: Cut flowers and pot plants: harvesting control of roses by means of pruning practices. 1983. D.I. Ferreira

Pome and stone fruits/Kern- en steenvrugte

APPLES/APPELS

PHYSIOLOGY/FISIOLOGIE

*VV.2441/03/2/2: Presence of phyto-allexins in apple trees and their role in disease resistance. 1982. C.A. Gillham

VV.2441/03/2/3: A test for the occurrence of specific replant diseases of apples. 1982. L. van Zyl

VV.2441/03/2/4: Induction and development of syllepsis on apple trees in the nursery. 1983. K.I. Theron

VV.2441/03/3/1: The mode of action of triadimefon (Bayleton) in increasing the fruit set of Starking apples. 1982. L. Gouws

VV.2441/03/5/1: Determination of the correct maturity indices for apples. 1978. A.B. Truter

VV.2441/03/6/1: Calcium-dip treatments for bitterpit control. 1976. T.R. Visagie

VV.2441/03/6/3: Control of russetting on apples. 1981. J. Steenkamp

VV.2441/03/6/4: An anatomical study of apple russetting. 1981. P. van der Merwe

VV.2441/03/6/6: Uptake and translocation of silicon by the apple tree. 1982. J. Steenkamp

*Facet terminated / Faset gestaak

APPELS

VV.2441/03/6/7: The influence of nitrogen and potassium nutrition on the synthesis of organic acids and the incidence of bitterpit in apples. 1983. J. Steenkamp

VV.2441/03/6/8: A study of the muddy brown discoloration of Starkrimson apples. 1982. C.F. Hansmann

NUTRITION/VOEDING

VV.2441/05/1/2: Potassium-supplying powder of apple orchard soils. 1977. J. Wooldridge

VV.2441/05/1/4: Mapping of FFTRI Experiment Farm apple orchard soils. 1975. J. Wooldridge

VV.2441/05/2/4: Demonstration fertilisation experiments in apple orchards. 1973. G. Schliemann

UPGRADING/VEREDELING

VV.2441/07/1/1: Breeding of a Granny Smith type apple with a compact growth habit by means of mutation breeding. 1977. J.H. Acker

VV.2441/07/1/2: Breeding of apple cultivars resistant to scab. 1977. J.H. Acker

VV.2441/07/1/3: Breeding of late red apple cultivars. 1977. J.H. Acker

VV.2441/07/1/4: Development of tissue culture techniques for use with mutation breeding on apples. 1978. R.E. Pieterse

VV.2441/07/1/5: Breeding of apple cultivars with a compact growth habit. 1977. J.H. Acker

PATHOLOGY/PATOLOGIE

VV.2441/19/1/2: Investigation of curative and protective characteristics of existing and new fungicides for apple scab control. 1981. W.F.S. Schwabe

VV.2441/19/1/3: Studies concerning requirements for apple fruit infection by *Venturia inaequalis*. 1981. W.F.S. Schwabe

VV.2441/19/1/4: Implementation of an apple scab warning service. 1981. W.F.S. Schwabe

VV.2441/19/1/6: Isolation techniques for collar and root rot pathogens of apples. 1982. M. Nicholson

PESTS/PLAE

VV.2441/20/1/1: Radiation sterilisation of the infesting stages of fruit flies. 1972. B.N. Barnes

VV.2441/20/2/1: Bionomics of snout beetles on apples. 1981. B.N. Barnes

VV.2441/20/2/2: Monitoring systems for pest mites and a mite predatory beetle on apples. 1981. K.L. Pringle

VV.2441/20/2/3: Bionomics of codling moth on apples. 1982. T.L. Blomefield

VV.2441/20/3/1: Survey of the different nematode species occurring in Western Cape apple orchards. 1979. H.J. Hugo

VV.2441/20/3/2: Chemical control of nematodes attacking apple trees. 1980. H.J. Hugo

CROP SCIENCE/GEWASKUNDE

VV.2441/30/1/1: The planting and maintenance of apple cultivars. 1972. J.V. Hadlow

VV.2441/30/1/2: Second phase evaluation of apple cultivars in the Western Cape. 1971. P.R. Jolly

VV.2441/30/1/3: Evaluation of Starking-type apples. 1978. P.R. Jolly

VV.2441/30/1/4: Evaluation of Golden Delicious apple types. 1979. P.R. Jolly

VV.2441/30/2/1: Evaluation of a number of imported apple rootstocks. 1971. O. Bergh

VV.2441/30/3/1: A comparison of training systems for apples in the Elgin area. 1969. O. Bergh

VV.2441/30/3/2: The pruning of close-planted apples. 1972. O. Bergh

VV.2441/30/3/3: Training systems for apples on dwarfing rootstocks. 1972. O. Bergh

VV.2441/30/4/1: Fruit size in apples. 1971. O. Bergh

VV.2441/30/6/1: Evaluation of grasses and legumes as cover crops in apple orchards of the Western Cape. 1983. R.E. Harris

METEOROLOGY/WEERKUNDE

VV.2441/33/1/1: Overhead cooling of apples. 1979. W.A.G. Kotzé

TECHNOLOGY/TEGNOLOGIE

VV.2441/52/1/1: Influence of gas composition during controlled atmosphere storage on the keeping quality of apples. 1978. A.B. Truter

VV.2441/52/1/3: Effect and rate of re-cooling and atmosphere modification on apple quality. 1984. A.J.M. van der Westhuizen

CHEMISTRY/CHEMIE

VV.2441/53/1/1: Development of an objective index for quality of apple juice based on the flavour components of apples. 1982. C.A.R. Hurt

VV.2441/53/1/2: Quantitative chemical analysis of apples by means of the scanning electron microscope and energy dispersive X-ray analysis. 1982. C.A.R. Hurt

PEARS/PERE

PHYSIOLOGY/FISIOLOGIE

VV.2442/03/2/1: The effect of viruses on the performance of pear cultivars. 1972. H.J. van Zyl

VV.2442/03/2/2: Growth control of pears with growth retardants. 1982. H.J. van Zyl

VV.2442/03/5/1: Effect of calcium, hormones and seed content on premature ripening of pears. 1982. H.J. van Zyl

VV.2442/03/5/2: The effect of post-harvest calcium-dip treatments on the keeping quality and ripening of pears. 1983. G.J. Eksteen

VV.2442/03/5/3: Effect of fluctuation in orchard temperature on premature ripening of pears. 1983. H.J. van Zyl

NUTRITION/VOEDING

VV.2442/05/1/1: Pears: determination of the effect of soil pH and of potassium and nitrogen fertilisation on the growth, yield and fruit quality of pears. 1982. J. Wooldridge

UPGRADING/VEREDELING

VV.2442/07/1/1: Breeding of precocious late pear cultivars. 1977. J.H. Acker

VV.2442/07/1/2: Breeding of pear cultivars resistant to scab. 1977. W.J.C. Smith

VV.2442/07/1/3: Breeding of a Packham's Triumph-type pear with a compact growth habit. 1977. J.H. Acker

PESTS/PLAE

VV.2442/20/1/1: Chemical control of codling moth on pears. 1977. T.L. Blomefield

CROP SCIENCE/GEWASKUNDE

VV.2442/30/1/1: The planting and maintenance of pear cultivars. 1970. C. van Zyl

VV.2442/30/1/2: Second phase evaluation of pear cultivars in the winter rainfall area. 1971. P.R. Jolly

VV.2442/30/2/1: Evaluation of pear rootstocks in the winter rainfall area. 1971. J.D. Stadler

VV.2442/30/3/1: Increasing of production of pears. 1978. P. van Huyssteen

VV.2442/30/3/2: Comparison of training systems for pears in the Groot-Drakenstein area. 1983. P. van Huyssteen

VV.2442/30/5/1: Rooting of BP2 pear rootstocks. 1978. P. van Huyssteen

VV.2442/30/5/2: Factors affecting the rooting and survival of BP2 pear rootstocks. 1975. J.H. Terblanche

TECHNOLOGY/TEGNOLOGIE

VV.2442/52/1/1: Controlled atmosphere storage of pears. 1982. A.B. Truter

VV.2442/52/1/2: Effect of rate of re-cooling and atmosphere modification on pear quality. 1984. A.J.M. van der Westhuizen

*VV.2442/52/2/3: Factors affecting the colour of canned pears. 1981. B.K. Nortjé

PEACHES/PERSKES

PHYSIOLOGY/FISIOLOGIE

VV.2443/03/2/1: Growth control of peaches with retardants. 1982. H.J. van Zyl

VV.2443/03/4/1: Determination of reliable maturity indices for peaches and nectarines. 1979. T.R. Visagie

NUTRITION/VOEDING

VV.2443/05/1/2: Scheduling of nitrogen application through the irrigation system for peaches (nectarines). 1982. M. du Preez

UPGRADING/VEREDELING

VV.2443/07/1/1: Breeding of canning peaches. 1971. P.F. Louw

VV.2443/07/1/2: Breeding of yellow flesh peach cultivars suitable for drying and dessert. 1979. P.F. Louw

VV.2443/07/1/3: Mutation breeding of nectarines by means of radiation. 1971. J.H. Acker

PESTS/PLAE

VV.2443/20/2/1: Bionomics of false codling moth on peaches. 1982. M.A. Huiskens

CROP SCIENCE/GEWASKUNDE

VV.2443/30/1/1: The planting and maintenance of peach cultivars. 1970. J.W. Etsebeth

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PEACHES

VV.2443/30/1/2: Second phase evaluation of peach cultivars in the Western Cape. 1971. C.W.J. Bester

VV.2443/30/1/5: Evaluation of peach breeding lines in Natal. 1981. J.H. Terblanche

VV.2443/30/2/2: Peaches: evaluation of peach rootstocks at Robertson Experiment Farm. 1982

WATER REQUIREMENTS/WATERBEHOEFTES

VV.2443/31/1/1: Lysimeter studies on irrigation scheduling with peaches. 1979. H. Tormann

TECHNOLOGY/TEGNOLOGIE

VV.2443/52/1/1: Controlled atmosphere storage of nectarine peaches. 1981. G.J. Eksteen

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VV.2443/52/1/3: Cooling rate and storage techniques to improve storage life and quality of peaches. 1983. G.J. Eksteen

PLUMS/PRUIME

PHYSIOLOGY/FISIOLOGIE

VV.2444/03/1/1: Development of a technique to regenerate plum plants from protoplasts. 1982. C. Thomas

VV.2444/03/3/1: Chemical manipulation of fruit set and thinning of plums (prunes). 1984. L. Gouws

VV.2444/03/4/1: Relationship between orchard temperature, fruit size, nutrient uptake and internal breakdown of plums. 1983. H. Tormann

NUTRITION/VOEDING

VV.2444/05/1/1: Determination of the lime requirement of plums. 1982. W.A.G. Kotzé

UPGRADING/VEREDELING

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PATHOLOGY/PATOLOGIE

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TECHNOLOGY/TEGNOLOGIE

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APRICOTS/APPELKOSE

NUTRITION/VOEDING

VV.2445/05/1/1: Effect of pre- and post-planting organic fertilisation on the performance of apricot trees on two training systems. 1982. M. du Preez

UPGRADING/VEREDELING

VV.2445/07/1/1: Breeding of early canning apricots. 1977. M.J. van Tonder

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CHERRIES/KERSIES

CROP SCIENCE/GEWASKUNDE

VV.2446/30/1/1: Second and third phase evaluation of cherry cultivars in the Western Cape. 1977. P.R. Jolly

Berry fruits/Bessievrugte

BERRIES/BESSIES

NUTRITION/VOEDING

VV.2451/05/1/1: Berries: effect of differential N and K fertilisation on production of two strawberry cultivars. 1983. C. Human

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VV.2451/07/1/1: Berries: utilisation of the genetic variation in strawberries on the octoploid level. 1972. J.H. Acker

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Viticulture/Wingerdbou

TABLE GRAPES/TAFELDRUIWE

PHYSIOLOGY/FISIOLOGIE

VV.2461/03/2/2: Cold-storage of table grapes - influence of pre- and post-harvest factors on berry splitting in Alphonse Lavallée. 1980. J.C. Combrink

VV.2461/03/5/1: Effect of soil moisture tension, time of harvest and delay in cooling on the incidence of drop berries in Waltham Cross grapes. 1980. J.C. Combrink

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NUTRITION/VOEDING

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UPGRADING/VEREDELING

VV.2461/07/1/1: Breeding of a late white table grape. 1977. P.J.L. Ellis

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VV.2461/19/1/1: Sources of survival of the table grape pathogen *Botrytis cinerea* and factors which influence dissemination. 1978. A.C. Thomas

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WINE GRAPES/WYNDRUIWE

ANATOMY/ANATOMIE

WW.2462/02/1/1: Wine grapes: anatomy and ultrastructure of one-year-old shoots of *Vitis*. 1981. E. Archer

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PHYSIOLOGY/FISIOLOGIE

WW.2462/03/1/1: The contribution of lateral shoots to cluster nutrition and to reserves in wine grapes: Cape Riesling. 1981. A.C. de la Harpe

NUTRITION/VOEDING

WW.2462/05/1/1: Effect of rootstock on the mineral status of scions. 1981. J.M. Southey

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Oenology/Wynkunde

WINE/WYN

CHEMISTRY/CHEMIE

WW.2471/53/1/3: Screening of volatile components in wine in relation to wine quality: Pinotage. 1981. P.C. van Rooyen

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BRANDY/BRANDEWYN

CHEMISTRY/CHEMIE

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Citrus and subtropical crops/Sitrus- en subtropiese gewasse

CITRUS/SITRUS

NUTRITION/VOEDING

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PHYSIOLOGY/FISIOLOGIE

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SS.2483/03/2/1: Development of tissue culture techniques for the production of embryogenic callus and protoplasts in avocados. 1984. P. Harty

SS.2483/03/2/2: Development of shoot tip grafting technique in avocados. 1984. M. Nel

SS.2483/03/2/3: Establishment and multiplication of rooted avocado plantlets in culture. 1984. P.A. Harry

AVOCADO

NUTRITION/VOEDING

SS.2483/05/1/1: Macro- and micro-element requirements of avocados. 1970. T.J. Koen

PATHOLOGY/PATOLOGIE

SS.2483/19/1/2: Resistance of avocado cultivars to root rot. 1972. J.N. Moll

SS.2483/19/1/3: Chemical control of avocado root rot. 1984. J.A. Herbert

PESTS/PLAE

SS.2483/20/1/1: Fruit fly studies on avocados. 1972. W.J. du Toit

TECHNOLOGY/TEGNOLOGIE

SS.2483/52/1/1: Improvement of the shelf life of avocados. 1963. D.H. Swarts

BANANAS/PIESANGS

NUTRITION/VOEDING

SS.2484/05/1/1: Optimum leaf analysis for bananas. 1970. W. Langenegger

UPGRADING/VEREDELING

SS.2484/07/1/1: The evaluation of promising banana selections. 1968. J.C. Robinson

PATHOLOGY/PATOLOGIE

SS.2484/19/1/1: Control of Panama wilt in bananas. 1976. B.Q. Manicom

CROP SCIENCE/GEWASKUNDE

SS.2484/30/1/1: Determination of optimal plant population and spacial arrangements for bananas. 1980. J.C. Robinson

SS.2484/30/1/2: Crop timing and forecasting with bananas in relation to time of planting, sucker selection, spacing and locality. 1980. J.C. Robinson

WATER REQUIREMENTS/WATERBEHOEFTES

SS.2484/31/1/1: Investigation of irrigation schedules and systems for bananas. 1981. J.C. Robinson

TECHNOLOGY/TEGNOLOGIE

SS.2484/52/1/1: Improvement of the shelf life of bananas. 1975. D.H. Swarts

DIVERSE SUBTROPICAL FRUITS/ALLERLEI SUBTROPIESE VRUGTE

PHYSIOLOGY/FISIOLOGIE

SS.2485/03/1/1: Diverse subtropical fruits: flower and fruit development with relation to mangoes. 1972. P.D.F. Mullins

SS.2485/03/1/2: Diverse subtropical fruits: radioimmunoassay of fruit development with mangoes. 1981. J.G.M. Cutting

ALLERLEI SUBTROPIESE VRUGTE

NUTRITION/VOEDING

SS.2485/05/1/1: Diverse subtropical fruits: macro- and micro-element requirements of litchis. 1968. T.J. Koen

SS.2485/05/1/2: Diverse subtropical fruits: macro- and micro-element requirements of guavas. 1981. G. Smart

SS.2485/05/1/3: Diverse subtropical fruits: macro- and micro-element requirements of granadillas. 1973. G. Smart

SS.2485/05/1/4: Diverse subtropical fruits: macro- and micro-element requirements of papayas. 1980. G. Smart

SS.2485/05/1/5: Diverse subtropical fruits: macro- and micro-element requirements of mangoes. 1972. B.L. Smith

UPGRADING/VEREDELING

SS.2485/07/1/1: Diverse subtropical fruits: breeding and selection of relation to papayas. 1978. A.J. Joubert

SS.2485/07/1/2: Diverse subtropical fruits: breeding and selection of relation to mangoes. 1971. J.C. Snyman

SS.2485/07/1/3: Diverse subtropical fruits: breeding and selection of relation to guavas. 1970. L.C. Bolt

SS.2485/07/1/4: Diverse subtropical fruits: breeding and selection of relation to litchis. 1981. L.C. Bolt

PATHOLOGY/PATOLOGIE

SS.2485/19/1/1: Diseases of diverse subtropical fruits: life cycle and control of bacterial black spot of mangoes. 1972. B.Q. Manicom

SS.2485/19/1/2: Diverse subtropical fruits: life cycle and control of mango flower malformation. 1978. J.F. Dames

SS.2485/19/1/3: Diverse subtropical fruits: life cycle and control of blossom-end rot in guavas. 1982. N.M.G. Grech

SS.2485/19/1/4: Diverse subtropical fruits: control of Malelane dieback in guavas. 1982. N.M.G. Grech

PESTS/PLAE

SS.2485/20/1/1: Diverse subtropical fruits: the occurrence and control of known and new pests. 1972. E.A. de Villiers

CROP SCIENCE/GEWASKUNDE

SS.2485/30/1/1: Diverse subtropical fruits: pruning times in relation to guavas. 1974. A.J. Alberts

SS.2485/30/1/2: Diverse subtropical fruits: pruning systems with relation to guavas. 1974. A.J. Alberts

SS.2485/30/2/1: Testing of diverse subtropical fruits in different localities. 1983. A.J. Joubert

TECHNOLOGY/TEGNOLOGIE

SS.2485/52/1/1: Diverse subtropical fruits: post-harvest handling with relation to mangoes. 1971. D.H. Swarts

SS.2485/52/1/2: Diverse subtropical fruits: post-harvest handling with relation to papayas. 1971. D.H. Swarts

OTHER SUBTROPICAL CROPS/ANDER SUBTROPIESE GEWASSE

ANATOMY/ANATOMIE

SS.2486/02/1/1: Other subtropical crops: flower and fruit formation studies in relation to bixa. 1980. M.W. Venter

NUTRITION/VOEDING

SS.2486/05/1/1: Other subtropical crops: macro- and micro-element requirements of tea. 1975. B.L. Smith

UPGRADING/VEREDELING

SS.2486/07/1/1: Other subtropical crops: breeding and selection of tea. 1971. J.C. Snyman

PESTS/PLAE

SS.2486/20/1/1: Other subtropical crops: the occurrence and control of pests on tea. 1972. A. Schwartz

CROP SCIENCE/GEWASKUNDE

SS.2486/30/1/1: Planting distances for other subtropical crops with relation to coffee. 1980. K. de Rooster

SS.2486/30/2/1: Testing of other subtropical crops in different localities. 1975. A.J. Joubert

Nut crops/Neutgewasse

NUTS/NEUTE

NUTRITION/VOEDING

SS.2491/05/1/1: Macro- and micro-element requirements of macadamia nuts. 1968. L.L. Hoffmann

SS.2491/05/1/2: Macro- and micro-element requirements of pecan nuts. 1969. T.J. Koen

PATHOLOGY/PATOLOGIE

SS.2491/19/1/1: Control of scab on pecans. 1980. B.Q. Manicom

PESTS/PLAE

SS.2491/20/1/1: The occurrence and control of pests on nut crops. 1972. E.A. de Villiers

CROP SCIENCE/GEWASKUNDE

SS.2491/30/1/1: Testing of macadamia cultivars in different localities. 1969. A.J. Joubert

SS.2491/30/1/2: Testing of pecan nut cultivars. 1971. A.J. Joubert

SS.2491/30/2/1: Testing of planting distances of macadamia nuts. 1971. A.J. Joubert

VV.2491/30/1/1: Second phase evaluation of almond cultivars in the Western Province. 1971. E.J. van Zyl

CHEMISTRY/CHEMIE

VV.2491/53/1/1: Nuts: effect of the changes in oil and antitoxidants during storage on the taste of almonds. 1982. P.C. Fourie

Radioisotopes/Radioïsotope

RADIOISOTOPY/RADIOïSOTOPIE

CHEMISTRY/CHEMIE

VV.24*10*1/53/1/2: Radiochemical separation of 28 Mg and 28 Al in a radioisotope generator. 1983. J.M. le Roux

PHYSICS/FISIKA

VV.24*10*1/54/1/2: Determination of soil moisture and density near the soil surface with neutron and gamma-ray radioisotope techniques. 1979. J.H.M. Karsten

Sundry horticultural crops/Diverse tuinbougewasse

HORTICULTURAL CROPS/TUINBOUGEWASSE

PHYSIOLOGY/FISIOLOGIE

TB.24*11*1/03/1/1: The rapid multiplication of sundry horticultural crops: guayule by means of tissue culture techniques. 1983. Josephine C. Janse van Rensburg

VV.24*11*1/03/1/2: Horticultural crops: the morphology of red and white seed of red tea. 1982

VV.24*11*1/03/2/1: Selection and stimulation of nucellar embryos of dates. 1981. P.F. Nortjé

VV.24*11*1/03/2/2: Propagation of dates by means of tissue culture. 1981. B. Ellis

VV.24*11*1/03/2/3: Horticultural crops: rooting of small date offshoots. 1982. L.J. von Mollendorf

VV.24*11*1/03/3/1: Horticultural crops: vegetative propagation of difficult-to-root olive cultivars. 1983. C. Costa

NUTRITION/VOEDING

VV.24*11*1/05/1/1: Horticultural crops: uptake of nutrients by olive leaves. 1982. O. Beukes

VV.24*11*1/05/1/2: Horticultural crops: nitrogen, potassium and boron fertilisation of olives. 1981. J.A. Carreira

VV.24*11*1/05/2/1: Horticultural crops: available phosphate and potassium for red tea. 1983. M.E. Joubert

VV.24*11*1/05/3/1: Horticultural crops: seasonal uptake of nutrient elements by kiwi fruit. 1983. J.F. de Villiers

UPGRADING/VEREDELING

VV.24*11*1/07/1/1: Horticultural crops: a morphological study of the breeding structure of red tea types. 1977. J.P. Human

VV.24*11*1/07/1/2: Horticultural crops: breeding of improved red tea types. 1977. J.H. Acker

HORTICULTURAL CROPS

PATHOLOGY/PATOLOGIE

VV.24*111*/19/1/1: The role of fungus pathogens in the early dieback of red tea. 1980. W.A. Smit

CROP SCIENCE/GEWASKUNDE

VV.24*111*/30/1/1: Horticultural crops: evaluation of imported olive cultivars in the Paarl, Clanwilliam and Robertson areas. 1981. R. Verbruggen

VV.24*111*/30/1/2: Horticultural crops: evaluation of olive mutations and seedlings in the Paarl and Robertson areas. 1982. J.A. van Zyl

VV.24*111*/30/1/3: Horticultural crops: evaluation of olive rootstocks in the Paarl and Robertson areas. 1982. C. Costa

VV.24*111*/30/2/1: Horticultural crops: planting and training systems for olives. 1982. J.A. van Zyl

VV.24*111*/30/2/2: Horticultural crops: crop control of olives in the Paarl area. 1982. J.A. van Zyl

VV.24*111*/30/7/1: Second phase evaluation of fig cultivars in the Western Province. 1974. E.J. van Zyl

VV.24*111*/30/8/1: Horticultural crops: second and third phase evaluations of kiwi fruit cultivars in the Western and Southern Cape. 1977. J.D. Stadler

VV.24*111*/30/9/1: Horticultural crops: horticultural studies on the kiwi fruit. 1982. J.H. Terblanche

TECHNOLOGY/TEGNOLOGIE

VV.24*111*/52/1/1: Horticultural crops: influence of growing conditions on the quality of processed olives. 1982. P.C. Fourie

VV.24*111*/52/2/1: Horticultural crops: preparation for acceptable instant products from waste materials of red tea. 1983. E. Joubert

PLANT PROTECTION RESEARCH/PLANTBESKERMINGSNAVORSING

Entomology/Zoology/Insektekunde/Dierkunde

INSECTS/INSEKTE

TAXONOMY/TAKSONOMIE

PB.2511/01/1/1: Collection of southern African insects. 1910. G.L. Prinsloo

PB.2511/01/1/2: Taxonomy of Isoptera in southern Africa. 1946. W.G.H. Coaton

PB.2511/01/1/3: Taxonomy of Tephritidae in southern Africa. 1922. H.K. Munro

PB.2511/01/1/5: Taxonomy of parasitic wasps, Chalcidoidea. 1970. G.L. Prinsloo

*PB.2511/01/1/6: Taxonomy of southern African Saturniidae. 1974. H. Geertsema

PB.2511/01/1/7: Taxonomy of Neuroptera. 1977. M.W. Mansell

PB.2511/01/1/8: Taxonomy of Bruchidae. 1978

PB.2511/01/1/9: Taxonomy of Hymenoptera Aculeata. 1978. C.D. Eardly

PB.2511/01/1/10: Taxonomy of Cicadellidae of southern Africa. 1973. J.G. Theron

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PESTS/PLAE

PB.2511/20/1/1: Migratory locust control by aerial spray application. 1981. H.D. Brown

PB.2511/20/1/2: The outbreak dynamics of the African migratory locust. 1981. H.D. Brown

PB.2511/20/2/1: Insects: predators of the harvester termite, *Hodotermes mossambicus*. 1984. A. Nel

PB.2511/20/2/2: Insects: bat-eared jackals (*Otocyon megalotis*) as consumers of harvester termites (*Hodotermes mossambicus*). 1984. A. Nel

BIOLOGICAL CONTROL/BIOLOGIESE BEHEER

PB.2511/22/2/1: The use of natural enemies to control stalk borers in cereal crops. 1978. H. van Hamburg

INTEGRATED CONTROL/GEïNTEGREERDE BEHEER

PB.2511/23/1/1: Laboratory evaluation of candidate pesticides against the American bollworm. 1978. N.C.J. Basson

PB.2511/23/1/2: The effect of pesticides applied under field conditions against *H. armigera* on natural enemies and red spider mite. 1978. N.C.J. Basson

PB.2511/23/1/3: Pesticide resistance of *H. armigera* in South Africa. 1978. N.C.J. Basson

PB.2511/23/1/5: The use of natural enemies to control *H. armigera*. 1978. H. van Hamburg

PB.2511/23/2/1: The use of imported wasp parasites and improved vineyard management to improve the control of the insect *P. ficus*. 1978. A.J. Urban

PB.2511/23/4/1: Insects: biology of parasitic wasps (Hymenoptera) attacking scale insects of economic importance. 1980. H. van Hamburg

NEMATODES/AALWURMS

TAXONOMY/TAKSONOMIE

PB.2512/01/1/1: Collection of nematodes in southern Africa. 1962. Esther van den Berg

PB.2512/01/1/3: Taxonomy of root knot nematodes, *Meloidogyne* spp. 1981. K.P.N. Kleynhans

PB.2512/01/1/4: Taxonomic study of the South African Longidoridae. 1976. Esther van den Berg

PESTS/PLAE

PB.2512/20/1/3: Influence of nursery practices on the nematode population in vineyards in the Western Cape. 1982. W. Pieterse

PB.2512/20/1/4: The use of tissue culture for the *in vitro* propagation of economically important nematode species. 1984. Antoinette P. van Mieghem

MITES/MYTE

TAXONOMY/TAKSONOMIE

PB.2513/01/1/1: Collection of mites of agricultural importance. 1959. M.P.K. Meyer

PB.2513/01/1/2: Taxonomy and biology of predacious mites in South Africa. 1962. E.A. Ueckermann

PB.2513/01/1/3: Taxonomic free-living Acari, especially those belonging to the sub-order Mesostigmata. 1976. M.K.P. Meyer

MITES

PESTS/PLAE

PB.2513/20/1/1: Laboratory evaluation of candidate pesticides against *Tetranychus* spp. 1978. D. Lombaard

PB.2513/20/1/2: Evaluation of promising pesticides under field conditions against *Tetranychus* spp. 1978. J.H. Botha

PB.2513/20/1/3: Determination of resistance of *Tetranychus* spp. to pesticides. 1978. D. Lombaard

SPIDERS/SPINNEKOPPE

TAXONOMY/TAKSONOMIE

PB.2514/01/1/1: Taxonomy of agriculturally important spiders. 1976. A.S. Dippenaar

RODENTS/KNAAGDIERE

PESTS/PLAE

PB.2515/20/1/1: The control of *Tatera brantsii* and *Praomys (Mastomys) natalensis*. 1969. S. Stiemie

HONEY-BEE/HEUNINGBY

NUTRITION/VOEDING

PB.2516/05/1/1: Stimulatory feeding of honey-bees. 1972. J.M. Herrmann

PB.2516/05/1/2: Nectar and pollen flora of South Africa. 1969. M.F. Johannsmeier

PB.2516/05/1/3: The effect of *Drosophila* spp. on the nectar supply of eucalyptus flowers. 1983. J.M. Herrmann

UPGRADING/VEREDELING

PB.2516/07/1/1: The selection of improved breeding lines of honey-bees. 1972. R.H. Anderson

PATHOLOGY/PATOLOGIE

PB.2516/19/1/1: Diseases of the adult honey-bee. 1976. B. Buys

BEHAVIOURAL STUDIES/GEDRAGSTUDIES

PB.2516/28/1/1: The behaviour of honey-bees in orchards during pollination. 1972. R.H. Anderson

PB.2516/28/1/2: Honey-bee: development and testing of bee-wax foundation of greater cell size than that currently employed in South Africa to increase profitability of honey production through minimisation of wax required for comb construction. 1981. H.R. Hepburn

STORED GRAIN/OPGEBERGDE GRAAN

PESTS/PLAE

PB.2518/20/1/1: The use of contact material to control insects in stored grain and grain products. 1955. J.H. Viljoen

PB.2518/20/1/2: The use of poisonous and inert gasses to control storage pests. 1959. J.H. Viljoen

PB.2518/20/1/3: Insecticidal resistance by *Tribolium* species. 1976. J.H. Viljoen

FOREST AND TIMBER/BOSBOME EN TIMMERHOUT

PESTS/PLAE

PB.2519/20/1/1: The biology, fungal associations and control of bark beetles on pine trees. 1979. G.D. Tribe

PB.2519/20/1/2: The control of timber insects. 1955. J.K. Winstanley

PB.2519/20/1/3: The biology, pest status and control of the black pine aphid. 1977. N.J. van Rensburg

PB.2519/20/1/4: Forest and timber: the biology of the pine woolly aphid. 1982. W.A. Bruzas

Plant pathology/Microbiology/Plantpatologie/Mikrobiologie

FUNGI/SWAMME

TAXONOMY/TAKSONOMIE

PB.2521/01/1/1: Identification of diverse fungi. 1973. C. Roux

PB.2521/01/1/2: Edible, inedible and poisonous mushrooms, toadstools and other fungi. 1973. G.C.A. van der Westhuizen

PB.2521/01/1/3: *Phialophora*-like fungi on roots of Gramineae. 1973. B. de Scott

PB.2521/01/1/4: Taxonomy of fungi: Coelomycetes of South Africa. 1982. C. Roux

PB.2521/01/1/5: The species of the fungus genus *Phytophthora* in South Africa. 1982. A.H. Thompson

MYCOLOGY/MIKOLOGIE

PB.2521/11/1/1: Examination of diverse feeds for toxigenic fungi. 1978. C. Roux

PB.2521/11/1/2: Role of toxigenic fungi in the occurrence of hepatogenous photosensitivity in livestock. 1971. C. Roux

PB.2521/11/2/1: Vesicular-arbuscular mycorrhizal fungi. 1982. B. de Scott

PB.2521/11/2/2: Fungi associated with feeder root diseases of cereals. 1983. B. de Scott

PATHOLOGY/PATOLOGIE

PB.2521/19/1/1: Pathogenic fungi on diverse seeds. 1975. M.A. Holtzhausen

PB.2521/19/1/2: Seed-borne fungi of dry beans. 1982. A.P. Baxter

PB.2521/19/2/1: Distribution and host range of the fungus *Phytophthora cinnamomi*. 1977. S.L. von Broembsen

PB.2521/19/2/2: Survival and spread of the fungus *Phytophthora cinnamomi* in soil. 1977. S.L. von Broembsen

PB.2521/19/2/3: Root and collar rot of cultivated proteas caused by the fungus *Phytophthora cinnamomi*. 1977. S.L. von Broembsen

PB.2521/19/2/4: Spread and survival of the fungus *Phytophthora cinnamomi* in rivers and natural waters. 1977. S.L. von Broembsen

PB.2521/19/3/1: Epidemiology and control of diseases caused by the fungus *Sclerotinia sclerotiorum*. 1982. G.W. Herd

BACTERIA/BAKTERIEë

NITROGEN FIXATION/STIKSTOFBINDING

PB.2522/09/1/1: Testing of commercial bacterial inoculants for legumes. 1967. B.W. Strijdom

PB.2522/09/1/2: Selection of *Rhizobium* bacteria for inoculants. 1968. C.J. Otto

PB.2522/09/1/3: Role of lectins in specificity of *Rhizobium* bacteria. 1975. I.J. Law

PB.2522/09/1/4: Relative importance of nitrogen-fixing ability when selecting *Rhizobium* bacteria for inoculants. 1976. H. Jansen van Rensburg

PB.2522/09/1/8: Establishment of nitrogen-fixing bacteria in soil. 1981. H. Jansen van Rensburg

PATHOLOGY/PATOLOGIE

PB.2522/19/1/1: Identification and control of bacterial pathogens of crops from various Regions and Institutes. 1979. C.C. Deschodt

PB.2522/19/1/2: Elimination of seed-borne bacterial pathogens from bean seed. 1974. C.C. Deschodt

PLANT DISEASES/PLANTSIEKTES

PATHOLOGY/PATOLOGIE

PB.2524/19/1/1: Data bank of diseases of plants handled by the quarantine station at Stellenbosch. 1980. P. von Maltitz

FOREST AND TIMBER/BOSBOME EN TIMMERHOUT

PATHOLOGY/PATOLOGIE

PB.2525/19/1/1: Routine examination of diseased material from forest trees. 1975. M.J. Wingfield

PB.2525/19/1/2: Survey of diseases of forest trees in plantations. 1975. M.J. Wingfield

PB.2525/19/1/3: Survey of diseases in forest tree nurseries. 1975. M.J. Wingfield

PASTURE CROPS/WEIDINGSGEWASSE

PATHOLOGY/PATOLOGIE

PB.2526/19/1/2: Survey of diseases of planted leguminous pasture crops in the summer rainfall areas. 1979. L.J. Mills

PB.2526/19/1/4: Occurrence and distribution of pasture crop diseases in the Western Cape: *Medicago* spp. 1982. S.C. Lamprecht

PB.2526/19/1/5: Evaluation of disease resistance in the Western Cape - *Medicago* spp. 1982. S.C. Lamprecht

PB.2526/19/1/6: *Phytophthora* root rot of the pasture crop lucerne. 1982. A.H. Thompson

PB.2526/19/1/7: Evaluation of imported cultivars of the pasture crop lucerne for disease resistance. 1983. A.H. Thompson

Phytosanitary research and activities/Fitosanitêre navorsing en aktiwiteite

VIRUSES/VIRUSSE

PATHOLOGY/PATOLOGIE

PB.2531/19/1/1: The detection and identification of virus diseases of grapevines. 1970. D.J. Engelbrecht

PB.2531/19/1/2: Elimination of virus diseases in grapevines. 1970. D.J. Engelbrecht

PB.2531/19/1/3: Detection and identification of virus diseases of deciduous fruit. 1970. J. Thatcher

PB.2531/19/1/4: Evaluation and application of indicator plants in the detection and identification of virus diseases in pome fruit. 1982. V.Z. Siebert

PB.2531/19/1/5: Development and application of immunological procedures for the detection and identification of viruses of pome and stone fruit. 1982. J. Thatcher

PB.2531/19/1/6: The elimination of virus diseases of pome and stone fruit. 1982. R. Human

PB.2531/19/2/1: Routine identification of virus diseases in plants, excluding leguminous and grass crops. 1980. G. Pietersen

PB.2531/19/2/2: Virus diseases of cassava, *Manihot esculenta*. 1980. G. Pietersen

PB.2531/19/2/3: Detection and identification of seed-borne virus diseases of forage and pasture legumes. 1980. G. Pietersen

PB.2531/19/2/4: Virus diseases of maize. 1980. G. Pietersen

BACTERIA/BAKTERIEë

PATHOLOGY/PATOLOGIE

PB.2532/19/1/1: Control of crown gall bacteria by chemical and physical methods. 1978. F.G.H. van Zyl

PB.2532/19/1/2: Biological control of crown gall bacteria. 1978. F.G.H. van Zyl

PB.2532/19/1/3: Occurrence of crown gall bacteria on different host plants. 1978. F.G.H. van Zyl

PB.2532/19/1/4: Diagnosis of bacterial diseases of phytosanitary importance on propagation material. 1982. P.M. von Maltitz

PB.2532/19/1/5: Development of standard isolation and identification procedures for bacterial pathogens of phytosanitary importance. 1982. P.M. von Maltitz

PB.2532/19/1/6: Elimination of bacterial plant pathogens of phytosanitary importance from propagation material. 1982. P.M. von Maltitz

*PB.2532/19/1/7: Biotyping of pathogenic crown gall bacteria of grapevines in Transvaal. 1982. J.L. Staphorst

PB.2532/19/1/8: Development of agrocin-producing strains of *Agrobacterium tumefaciens*. 1984. F.G.H. van Zyl

FUNGI/SWAMME

PATHOLOGY/PATOLOGIE

PB.2533/19/1/1: Detection of fungal diseases of phytosanitary importance on propagation material. 1982. P.M. von Maltitz

*Facet terminated/Faset gestaak

PB.2533/19/1/2: Development of standard procedures for isolation and identification of fungal pathogens of phytosanitary importance. 1982. P.M. von Maltitz

PB.2533/19/1/3: Elimination of fungal plant pathogens of phytosanitary importance from propagation material. 1982. P.M. von Maltitz

INSECTS/INSEKTE

PESTS/PLAE

PB.2534/20/1/1: Data bank of insect pests of plants handled by the Stellenbosch quarantine station. 1984. A.J. Els

Electron microscopy/Elektronmikroskopie

ELECTRON MICROSCOPY/ELEKTRONMIKROSKOPIE

TECHNOLOGY/TEGNOLOGIE

PB.2541/52/1/1: Preparation and examination of biological specimens by electron microscopy. 1979. H.J. van Tonder

Weed research/Onkruidnavorsing

WEEDS/ONKRUIDE

PHYSIOLOGY/FISIOLOGIE

PB.2551/03/1/1: Physiology of veld invader weeds' seed germination. 1981. J.L. Graaf

PB.2551/03/2/1: Uptake and translocation of herbicides by the weed bramble (*Rubus* spp.). 1981. D.J. Erasmus

CHEMICAL CONTROL/CHEMIESE BEHEER

PB.2551/21/1/1: Chemical control of the weed jointed cactus (*Opuntia aurantiaca*). 1960. H.G. Zimmermann

PB.2551/21/1/2: Chemical control of the weed nassella tussock (*Stipa trichotoma*). 1980. G.B. Harding

PB.2551/21/1/3: Chemical control of the weed mesquite (*Prosopis* spp.). 1983. G.B. Harding

PB.2551/21/1/6: Chemical control of the jointed cactus weed. 1980. S. Neser

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PB.2551/22/1/1: Biological control of the weed jointed cactus (*Opuntia aurantiaca*). 1960. H.G. Zimmermann

PB.2551/22/1/3: Mass-rearing and population dynamics of *Tucumania tapiacola*, a biocontrol agent of jointed cactus. 1976. J.H. Hoffmann

PB.2551/22/1/4: Biological control of the weed prickly pear (*Opuntia ficus-indica*). 1960. H.G. Zimmermann

PB.2551/22/1/5: Biological control of the weed *Lantana camara*. 1972. C.J. Cilliers

PB.2551/22/1/6: Biological control of the weeds *Hakea sericea, H. gibbosa* and *H. sauveolens*. 1972. R.L. Kluge

PLAAGDODERS

PB.2551/22/1/7: Biological control of the weed *Hypericum perforatum*. 1972. R.L. Kluge

PB.2551/22/1/8: Biological control and management of cactus weeds, particularly jointed cactus in South Africa. 1977. S. Neser

PB.2551/22/2/1: A study of the diseases of some indigenous and exotic weeds which are caused by local pathogens. 1979. M.J. Morris

PB.2551/22/2/2: Biological control of *Acacia* weeds by means of pathogens. 1982. M.J. Morris

ECOLOGY/EKOLOGIE

PB.2551/27/1/1: Ecology of the weed *Acacia longifolia*. 1983. P.J. Pieterse

PB.2551/27/1/2: Ecology of the weed nassella tussock (*Stipa trichotoma*). 1983. D.C. Joubert

PESTICIDES/PLAAGDODERS

PHYSIOLOGY/FISIOLOGIE

PB.2552/03/1/2: Effect of pesticide breakdown in soils on phytotoxicity. 1984. E.R.I.C. Sandmann

CHEMISTRY/CHEMIE

PB.2552/53/1/2: Improvement of chromatographic resolution of pesticides. 1981. P.R. de Beer

PB.2552/53/1/3: Pesticides: determination of nematocides in wine grapes. 1980. Marelie Krause

PB.2552/53/1/4: Pesticide residues in raw vegetables, fruit and animal products. 1977. L.P. van Dyk

PB.2552/53/1/5: Analysis of pesticides and their residues affecting useful plants. 1983. P. Niewoudt

PB.2552/53/1/6: Research and improvement of pesticide analysis done by the WGPA. 1984. P.R. de Beer

ANIMAL PRODUCTION PROMOTION/DIERE-PRODUKSIEBEVORDERING

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH DIEREPRODUKSIE- EN DIEREPRODUKTENAVORSING

Animal production/Diereproduksie

BEEF CATTLE/VLEISBEESTE

UPGRADING/VEREDELING

VS.3111/07/1/1: Evaluation of beef bulls in upgrading: Bonsmara. 1980. D.J. Bosman

VS.3111/07/1/2: Beef cattle: evaluation of the Roodebos and Wesselsvlei Bonsmara breeding lines. 1982. D.J. Bosman

VS.3111/07/1/3: Upgrading studies on beef cattle - improving fertility by natural selection. 1984. M.M. Scholtz

DAIRY CATTLE/MELKBEESTE

PHYSIOLOGY/FISIOLOGIE

VS.3112/03/1/1: An investigation into *in vitro* culture techniques for hormone dependent mammary gland tissue in dairy cattle. 1983. J.P. van Zyl

VS.3112/03/1/2: Milk prolactin surge before and during parturition and production parameters in dairy cattle. 1983. J.P. van Zyl

REPRODUCTION/REPRODUKSIE

VS.3112/04/1/1: Milk progesterone in dairy cattle reproduction - pregnancy. 1982. G.W. Kay

NUTRITION/VOEDING

VS.3112/05/1/3: Ureum in complete diets for dairy cattle. 1982. L.J. Erasmus

GENETICS/GENETIKA

VS.3112/06/1/1: Genetic aspects of laminitis in dairy cattle. 1965. E.H.H. Meyer

UPGRADING/VEREDELING

VS.3112/07/1/1: Genetic variation in milk and butterfat production in the upgrading of dairy cattle. 1965. G.P. Kuhn

VS.3112/07/1/3: Milkability and milk quality characteristics in the upgrading of dairy cattle. 1971. J.H. Hofmeyr

MANAGEMENT/BESTUUR

VS.3112/41/1/1: Biological economic data-analysing service for dairy cattle. 1981. M.H. Neitz

MUTTON SHEEP/VLEISSKAPE

REPRODUCTION/REPRODUKSIE

VS.3113/04/1/1: Mutton sheep reproduction: short scrotum castration. 1977. J.P.C. Greyling

WOOLLED SHEEP/WOLSKAPE

UPGRADING/VEREDELING

VS.3114/07/1/1: Skin and fibre characteristics in the upgrading of woolled sheep. 1972. J.H. Dreyer

VS.3114/07/2/1: Upgrading of production characteristics of woolled sheep by means of cross-breeding. 1972. J.H. Hofmeyr

PELT SHEEP/PELSSKAPE

REPRODUCTION/REPRODUKSIE

VS.3115/04/1/1: Reproduction aspects in pelt sheep: freezing of Karakul semen. 1971. J.P.C. Greyling

UPGRADING/VEREDELING

VS.3115/07/1/1: Upgrading of pelt sheep - white Karakuls. 1980. J.H. Hofmeyr

MEAT GOATS/VLEISBOKKE

REPRODUCTION/REPRODUKSIE

VS.3117/04/1/1: Reproduction in the Boer goat: freezing of Boer goat semen. 1974. J.P.C. Greyling

VS.3117/04/1/2: Reproduction in the meat goat: Boer goats. 1980. J.P.C. Greyling

PIGS/VARKE

REPRODUCTION/REPRODUKSIE

VS.3119/04/1/3: Pigs: reproduction in gilts - puberty. 1982. C. Kemp

VS.3119/04/1/4: Pigs: reproduction in boars - seasonal growth. 1982. C. Kemp

NUTRITION/VOEDING

VS.3119/05/1/2: Dehydrated lucerne in pig production. 1979. E.H. Kemm

VS.3119/05/1/3: Protein deposition in pig nutrition. 1980. F.K. Siebrits

VS.3119/05/1/5: Pig nutrition: the "ideal protein" requirements of the growing pig. 1984. E.H. Kemm

VS.3119/05/1/6: Pig nutrition: qualitative and quantitative aspects and implications of wheat as feed source. 1984. F.K. Siebrits

CHICKENS/HOENDERS

NUTRITION/VOEDING

VS.311*0*/05/1/1: Nutrition of laying fowls - influence of calcium on phosphorus requirements. 1977. J. Erasmus

CHICKENS

VS.311*10*/05/1/2: Nutrition of laying fowls - lysine requirements. 1976. J. Erasmus

VS.311*10*/05/1/3: Nutrition of laying fowls - seasonal energy and protein levels. 1975. J. Erasmus

VS.311*10*/05/1/4: The use of grain sorghum (*Sorghum vulgare*) in chicken diets. 1982. I.P. Swart

UPGRADING/VEREDELING

VS.311*10*/07/1/1: Upgrading of laying fowls - sex-linked feather colour. 1972. G.F. Potgieter

VS.311*10*/07/1/2: Upgrading of laying fowls - red or gold feather colour. 1971. G.F. Potgieter

VS.311*10*/07/1/3: Upgrading of laying fowls - combining activity. 1971. G.F. Potgieter

VS.311*10*/07/1/4: Upgrading of laying fowls - Australorp. 1971. G.F. Potgieter

VS.311*10*/07/1/5: Upgrading of laying fowls - other breeds. 1972. G.F. Potgieter

VS.311*10*/07/1/6: Upgrading of laying fowl breeds - New Hampshire control flock. 1976. J.J. Joubert

VS.311*10*/07/1/7: Genotype environment interaction in laying fowls - upgrading of laying fowl breeds. 1976. J.J. Joubert

*VS.311*10*/07/1/8: Upgrading of laying of chicken breeds. 1980. J.J. Joubert

VS.311*10*/07/2/1: Upgrading of meat type male line fowls. 1975. J.J. Joubert

VS.311*10*/07/2/2: Upgrading of meat type hen line fowls. 1962. J.J. Joubert

OTHER POULTRY/ANDER PLUIMVEE

NUTRITION/VOEDING

VS.311*15*/05/1/1: Nutrient requirement of other poultry - Chinese geese. 1965. M.D. Olver

VS.311*15*/05/1/2: Nutrient requirement of other poultry feeding systems - ducks. 1977. M.D. Olver

UPGRADING/VEREDELING

VS.311*15*/07/1/1: Upgrading of other poultry - Hagedoorn system with ducks. 1965. M.D. Olver

Animal products/Diereprodukte

MEAT/VLEIS

NORM STUDIES/NORMSTUDIES

VS.3121/50/1/1: Meat production: skeletal muscle development - cattle. 1973. P.H. Heinze

VS.3121/50/1/2: Meat production: carcass evaluation - cattle. 1975. R.T. Naudé

VS.3121/50/1/3: Meat production: chilling of beef carcasses. 1976. R.T. Naudé

VS.3121/50/1/4: Meat production: carcass grading system - cattle. 1976. R.T. Naudé

VS.3121/50/1/8: Meat production: carcass grading system - small stock. 1981. G.G. Bruwer

VS.3121/50/1/9: Meat production: compensatory growth - cattle. 1982. J.F. du Bruyn

VS.3121/50/1/10: Meat production: microbiology of packed meat. 1981. G.L. Nortjé

VS.3121/50/1/11: Meat production: porcine stress syndromes. 1984. P.H. Heinze

*Facet terminated Faset gestaak

SUIWELPRODUKTE

VS.3121/50/1/12: Meat production: the influence of vacuum packaging films on beef quality. 1984. H.F.O. Bekker

MILK/MELK

MICROBIOLOGY/MIKROBIOLOGIE

VS.3123/08/1/2: Rapid tests for the bacterial evaluation of milk. 1982. W.C. Botha

VS.3123/08/1/5: Milk: preservation of milk samples for bacterial count tests. 1983. H.H.A. Lück

VS.3123/08/1/8: Rapid tests for estimating the psychrotrophic count of milk. 1984. H.H.A. Lück

VS.3123/08/3/2: The shelf life of aseptical-packaged pasteurised milk. 1983. J.F. Mostert

VS.3123/08/4/2: Milk: assay of antibiotics. 1983. H. Gavron

CHEMISTRY/CHEMIE

VS.3123/53/2/1: Discolourisation of UHT-milk. 1981

VS.3123/53/4/1: Natural and added iodine in milk. 1981. L.E. Smit

DAIRY PRODUCTS/SUIWELPRODUKTE

MICROBIOLOGY/MIKROBIOLOGIE

VS.3124/08/1/1: Dairy products: a genetic study of the group *N. streptococci*. 1981. H. Gavron

VS.3124/08/1/3: Dairy products: bacterial content of air in dairy factories. 1983. H.H.A. Lück

VS.3124/08/1/4: Dairy products: the influence of gas-producing heterofermentative *Lactobacilli* on the texture of cheese. 1983. H.H.A. Lück

VS.3124/08/2/2: Dairy products: the influence of non-starter organisms on Cheddar cheese. 1983. A.J. Kruger

VS.3124/08/2/3: Control of insect infestation during storage of dairy products. 1984. H.H.A. Lück

VS.3124/08/3/4: Enterotoxic *Escherichia coli* in dairy products. 1982. H.H.A. Lück

VS.3124/08/3/5: Dairy products: the evaluation of pathogenic bacteria in milk and cheese. 1983. H. Gavron

NORM STUDIES/NORMSTUDIES

VS.3124/50/1/1: Dairy products: production and quality of butter in South Africa. 1981. J.J. du Toit

VS.3124/50/1/2: Dairy products: production and quality of ice-cream in South Africa. 1983. J.J. Keller

TECHNOLOGY/TEGNOLOGIE

VS.3124/52/1/1: Dairy products: technique studies in the concentration of whey and skim milk by ultrafiltration. 1983. T.E.H. Downes

VS.3124/52/1/2: The use of products recovered by ultrafiltration in dairy products. 1972. T.E.H. Downes

VS.3124/52/1/3: Dairy products: the hidrolisates of whey proteins. 1983.

VS.3124/52/1/5: Dairy products: the development of a low-energy dairy spread with favourable spreadability. 1982. T.E.H. Downes

VS.3124/52/1/6: Dairy products: demineralisation, processing and utilisation of cheese whey. 1982. T.E.H. Downes

VS.3124/52/1/10: Hydrolysis of lactose in cheese whey for use in dairy products or other foods. 1984. T.E.H. Downes

VS.3124/52/2/1: Dairy products: criteria to determine the degree of ripening of cheese. 1976. J.A. Nieuwoudt

CHEMISTRY/CHEMIE

VS.3124/53/2/1: Dairy products: the discolourisation of coloured fermented milk drinks. 1982. J.F. Mostert

VS.3124/53/2/3: Dairy products: determination of proteinases in cheese. 1984. M.E. Seppä

VS.3124/53/3/1: Dairy products: methods to determine the degree of added milk powder to bread. 1981. L.E. Smith

VS.3124/53/3/2: The determination of the biological values of proteins in dairy products according to the tetrahymena-assay technique. 1981. J.P. Ireland

VS.3124/53/3/4: Dairy products: the identification of milk proteins in other foods. 1983. C.M. Potgieter

VS.3124/53/3/5: Dairy products: the quantitative determination of added whey protein to milk powder. 1983. C.M. Potgieter

VS.3124/53/3/6: Levels of linoleic acid (trans) in dairy products and oils before and after processing. 1984. L.D. Nourse

VS.3124/53/3/7: Dairy products *versus* processed oils as fat-energy source: the disturbance of the metabolism of all cis-linoleic acid by the transforms as measured by growth of broiler chicks. 1984. L.D. Nourse

VS.3124/53/3/8: Dairy products *versus* processed oils as fat-energy source: the disturbance of the metabolism of all cis-linoleic acid by the transforms as measured by uncontrolled cell proliferation in tissue cultures. 1984. L.D. Nourse

Supporting animal research/Ondersteunende veekundige navorsing

ANIMALS/DIERE

REPRODUCTION/REPRODUKSIE

VS.3133/04/1/1: Reproduction aspects in female farm animals: Bonsmara, Angora. 1984. G.W. Kay (suspended)

VS.3133/05/1/6: Feed intake in the nutrition of farm animals - feed characteristics. 1981. J.P. Pienaar

VS.3133/05/1/7: Simultaneous measurement of the components in the energy metabolism of farm animals. 1982. J. Viljoen

VS.3133/05/1/8: Animals: relationship between rumen fill and energy balance on roughage diets. 1983. P.H. Henning

VS.3133/05/1/9: Feed intake in the nutrition of farm animals - growth studies with beef steers under production conditions. 1984. J.P.Campher

VS.3133/05/1/10: Feed intake in the feeding of farm animals: quantification of digestive energy losses on different ruminant diets. 1984. N. Slabbert

VS.3133/05/2/2: Quality of blood and carcass meals in the nutrition of non-ruminant animals. 1978. G.A. Smith

VS.3133/05/2/5: Protein nutrition: protein turnover in muscle tissue of growing rats. 1984. C.D. Esterhuyse

VS.3133/05/3/1: Digestive physiology and metabolism aspects in the feeding of farm animals - bacteria, solid-particles attachment. 1968. R.I. Mackie

VS.3133/05/3/2: Digestive physiology and metabolism aspects in feeding of farm animals - bacteria, teff hay. 1969. R.I. Mackie

VS.3133/05/3/3: Digestive physiology and metabolism aspects in the feeding of farm animals - bacteria biuret. 1973. R.I. Mackie

VS.3133/05/3/4: Digestive physiology and metabolism aspects in the feeding of farm animals - glucose production. 1975. J.G. van der Walt

VS.3133/05/3/5: Digestive physiology and metabolism aspects in the feeding of farm animals - bacteria, solid-particle separation. 1976. R.I. Mackie

VS.3133/05/3/6: Digestive physiology and metabolism aspects in feeding of farm animals - proteolytic bacteria. 1976. R.I. Mackie

VS.3133/05/3/8: Digestive physiology and metabolism aspects in the feeding of farm animals - bacteria, lactic acid. 1976. R.I. Mackie

VS.3133/05/3/9: Digestive physiology and metabolism aspects in the feeding of farm animals - glucose tolerance. 1976. J.G. van der Walt

VS.3133/05/3/10: Digestive physiology and metabolism aspects in the feeding of farm animals - fasting. 1977

VS.3133/05/3/12: Digestive physiology and metabolism aspects in the feeding of farm animals - bacterial growth, Na^+ and K^+. 1980

VS.3133/05/3/13: Digestive physiology and metabolism aspects in the feeding of farm animals - tissue lipogenic precursors. 1982. J.G. van der Walt

VS.3133/05/3/14: Digestive physiology and metabolism aspects in animal feeding - growth constants, cellulolytic bacteria. 1973

VS.3133/05/3/15: Digestive physiology and metabolism aspects in animal feeding - microbial and feed protein. 1975

VS.3133/05/3/16: Digestive physiology and metabolism aspects in animal feeding - fibre-digesting bacteria. 1979

VS.3133/05/3/17: Digestive physiology and metabolism aspects in the feeding of farm animals: ammonia transport and its influence on nitrogen metabolism in rumen bacteria. 1984. Johanna J. Therion

VS.3133/05/3/18: Digestive physiology and metabolism aspects in the feeding of farm animals: regulation and control of proteases in pure cultures of rumen bacteria. 1984. E. Strydom

VS.3133/05/4/1: NaOH-treated wheat straw. 1977. H.S. Hofmeyr

VS.3133/05/4/4: Crop residues of by-products for animal nutrition - pigs and poultry. 1982. E.H. Kemm

VS.3133/05/6/1: Dietary components in feeds for animal feeding: prosessed maize. 1978

VS.3133/05/6/5: Dietary components in feeds for animal feeding: whole maize grain. 1984. J.P. Campher

GENETICS/GENETIKA

VS.3133/06/1/1: Genetic defects in farm animals - hipoplasies cattle. 1979. E.H.H. Meyer

VS.3133/06/1/2: Genetic aspects of polymorphism in farm animals - milk polimorphism. 1977. E.H.H. Meyer

VS.3133/06/1/3: Genetic aspects of haemoglobins in farm animals - cattle. 1977. E.H.H. Meyer

VS.3133/06/1/4: Genetic aspects of blood typing in farm animals. 1969. S.J. du Plessis

VS 3133/06/1/5: Genetic production models for farm animals - milk production. 1977. C.Z. Roux

VS.3133/06/1/6: Laboratory animals in genetic studies: efficiency of feed utilisation. 1978. M.M. Scholtz

VS.3133/06/1/7: Breeding of laboratory animals in genetic studies. 1977. E.H.H. Meyer

VS.3133/06/1/8: Laboratory animals in genetic studies - life time growth. 1981. C.Z. Roux

VS.3133/06/1/9: Genetic aspects of karyotyping in farm animals. 1978. E.H.H. Meyer

VS.3133/06/1/10: Laboratory animals in genetic studies: milk production estimation techniques - rats. 1982. M.M. Scholtz

VS.3133/06/1/11: The genetic maintenance of small animal populations and the effect of in-breeding on production characteristics. 1982. J.C. Greeff

UPGRADING/VEREDELING

VS.3133/07/1/1: Upgrading studies on indigenous animals - maintenance, evaluation and improvement of indigenous Sanga cattle. 1982. M.M. Scholtz

VS.3133/07/1/2: Upgrading studies on indigenous animals - cytogenetic studies on Nguni cattle. 1982. N.D. Nel

VS.3133/07/1/3: Upgrading of animals: the evaluation of highly fertile sheep - breeds and strains in crosses. 1982. J.C. Greeff

VETERINARY RESEARCH/VEEARTSENYKUNDIGE NAVORSING

Pathological investigations/Patologiese ondersoeke

PATHOLOGICAL INVESTIGATIONS/PATOLOGIESE ONDERSOEKE

ANATOMY/ANATOMIE

OP.3211/02/1/2: Pathological investigations: quantitative measurements of the normal ovine heart. 1982. S.J. Newsholme

PATHOLOGY/PATOLOGIE

OP.3211/19/1/1: Diagnostic pathological investigations into mortalities of animals through macro- and microscopical techniques. 1981. J.A.W. Coetzer

OP.3211/19/1/2: Diagnostic investigations into mortalities through electron microscopical techniques. 1981. L. Prozesky

OP.3211/19/2/3: Pathological investigations on and pathogenesis of African swine fever. 1981. J.A. Neser

OP.3211/19/2/4: Pathological investigations on and pathogenesis of *Salmonella typhimurium* infection on sheep. 1981. J.A. Neser

OP.3211/19/2/5: Pathological investigations on *Matricaria nigellaefolia* toxicosis. 1983. S.J. Newsholme

OP.3211/19/2/6: Pathological, virological and haematological investigations on calves infected with Wesselsbron disease virus. 1983. J.A.W. Coetzer

OP.3211/19/2/7: Pathological investigations: evaluation of methods for *post mortem* recognition of toxic injury in ovine myocardium. 1984. S.J. Newsholme

OP.3211/19/3/1: Pathological and ophthalmological investigations on vervet monkeys infected with Rift Valley fever virus. 1983. J.A.W. Coetzer

Food hygiene/Voedselhigiëne

ANIMAL FOODS/DIERLIKE VOEDSELS

PATHOLOGY/PATOLOGIE

OP.3221/19/1/1: Animal foods: diagnosis of mastitis as a herd problem. 1981. W.H. Giesecke

OP.3221/19/1/2: Animal foods: microscopical investigation of the teat tip and canal at different stages of udder development. 1982. I. Clayden

OP.3221/19/1/3: Animal foods: lacteal levels of glucose and frequencies of subclinical mastitis and other udder conditions. 1981. W.H. Giesecke

OP.3221/19/1/4: Animal foods: the surface condition of teat-cup liners in relation to udder health. 1982. W.H. Giesecke

OP.3221/19/1/5: Animal foods: the effect of teat dipping on subclinical udder conditions in dairy cows milked by a machine. 1982. W.H. Giesecke

OP.3221/19/1/6: Animal foods: a study of marker dyes and antibiotic levels in milk after udder treatment against mastitis. 1982. I. Clayden

OP.3221/19/1/7: Animal foods: normal bacterial flora on bovine udders as affected by age, breed and season. 1979. Anette M. Durand

OP.3221/19/1/8: Animal foods: metabolic activity of somatic cells in blood and milk of mastitic cows. 1982. Z.E. Kowalski

OP.3221/19/1/9: Animal foods: interlaboratory standardisation of somatic cell counts in cows' milk in the RSA. 1983. W.H. Giesecke

OP.3221/19/2/1: Animal foods: tissue reactions and antibiotic residues in slaughter stock injected with long-acting antibiotics. 1981. I. Clayden

OP.3221/19/3/1: Animal foods: potentially pathogenic micro-elements in animal feeds. 1981. K. Ogonowski

OP.3221/19/3/2: Animal foods: antibiograms of *Salmonella* spp. from commercial animal feeds. 1982. Anette M. Durand

OP.3221/19/3/3: Animal foods: antibiograms of *Escherichia coli* from commercial animal feeds. 1982. Anette M. Durand

TECHNOLOGY/TEGNOLOGIE

OP.3221/52/1/1: Animal foods: proteolytic preparation of meat for culturing of toxin production by *Clostridium* spp. 1982. Anette M. Durand

OP.3221/52/2/1: Animal foods: differentiation of the species origin of different meat types. 1983. W.H. Giesecke

Toxicological investigations/Toksikologiese ondersoeke

TOXIC SUBSTANCES/TOKSIESE STOWWE

TOXICOLOGY/TOKSIKOLOGIE

OP.3231/18/1/1: Diagnostics of poisoning of animals by toxic substances. 1981. T.S. Kellerman

OP.3231/18/2/1: The role of fungi, plants and toxic substances in the aetiology and pathogenesis of photosensitivity. 1971. T.S. Kellerman

OP.3231/18/2/3: The efficacy of acetamide in the prevention and treatment of experimentally induced gifblaar poisoning in sheep. 1984. T.S. Kellerman

TOXIC SUBSTANCES

OP.3231/18/2/4: Evaluation of the efficacy of medical and industrial activated charcoals in the prophylaxis and treatment of plant poisonings and mycotoxicoses. 1984. T.S. Kellerman

Internal parasite investigations/Interne-parasietondersoeke

HELMINTHS/HELMINTE

TAXONOMY/TAKSONOMIE

OP.3241/01/1/1: Identification of helminths and investigation of definite host ranges. 1983. A.J.M. Verster

OP.3241/01/1/2: The taxonomy and incidence of helminths of the Cape hyrax (*Procacia capensis*). 1983. E.L. Visser

PESTS/PLAE

OP.3241/20/1/1: Helminths: diagnosis of unknown internal parasite phenomena. 1981. J.A. van Wyk

OP.3241/20/2/1: Helminths: immunology and serology of cysticercosis of cattle and pigs. 1970. A.J.M. Verster

OP.3241/20/2/2: Helminths: effect of irradiation on the viability of measles in cattle. 1972. A.J.M. Verster

OP.3241/20/2/3: Helminths: immunity of sheep to the larval stage of *Taenia multiceps*. 1979. A.J.M. Verster

OP.3241/20/2/4: Helminths: infestation of goats with the larval stage of *Taenia multiceps*. 1971. A.J.M. Verster

OP.3241/20/2/5: Helminths: epidemiology of tapeworms of ruminants. 1982. E.L. Visser

OP.3241/20/2/6: Helminths: incidence and treatment of *Stilesia globipunctata* infestation in South Africa. 1983. E.L. Visser

OP.3241/20/3/1: Helminths: reinfestation of cattle with bilharzia. 1969. J.A. van Wyk

OP.3241/20/3/2: Helminths: influence of temperature on the development of the larval stages of *Fasciola* spp. 1979. R.M.R. Alves

OP.3241/20/3/3: Helminths: development of *Fasciola* spp. of cattle and sheep in various definitive hosts. 1978. R.M.R. Alves

OP.3241/20/3/4: Helminths: pathological physiology of *Schistosoma matthee* infestation of sheep and cattle. 1969. J.A. van Wyk

OP.3241/20/3/5: Helminths: epidemiology of paramphistomiasis. 1981. J.A. van Wyk

OP.3241/20/4/1: Helminths: economic importance of parafilariosis of cattle. 1977. I.H. Carmichael

CHEMICAL CONTROL/CHEMIESE BEHEER

OP.3241/21/1/1: Chemical control of helminths with special reference to resistance. 1982. J.A. van Wyk

TECHNOLOGY/TEGNOLOGIE

OP.3241/52/1/1: Helminths: long-term storage of pure strains of helminths. 1973. J.A. van Wyk

OP.3241/52/1/2: Recovery of helminths and/or their ova from animals. 1976. J.A. van Wyk

Reproduction investigations/Reproduksie-ondersoeke

INFERTILITY/ONVRUGBAARHEID

PATHOLOGY/PATOLOGIE

OP.3251/19/1/1: Diagnostics of infertility and abortion in animals. 1973. Lesley A. te Brugge

OP.3251/19/1/2: Serodiagnostics of infertility, abortion and other diseases. 1981. S. Herr

OP.3251/19/2/1: Infertility: reduced dose vaccination of adult cattle with *Brucella abortus* strain 19. 1981. S. Herr

OP.3251/19/2/2: Infertility: immunity to trichomoniasis in cattle. 1981. S. Herr

OP.3251/19/2/3: Infertility: ulcerative dermatosis in sheep. 1981. C.J.V. Trichard

OP.3251/19/2/4: Infertility: immune competence of the sheep's urogenital tract to *Actinobacillus seminis*. 1979. B.C. Jansen

OP.3251/19/2/5: Infertility: bacterial infections of the genitalia of sheep. 1981. B.C. Jansen

Entomological investigations/Entomologiese ondersoeke

EXTERNAL PARASITES/EKSTERNE PARASIETE

ENTOMOLOGY/ENTOMOLOGIE

OP.3261/14/1/1: External parasites: identification and systematics of insects of veterinary importance. 1981. E.M. Nevill

ACAROLOGY/AKAROLOGIE

OP.3261/15/1/1: External parasites: identification and systematics of ticks and mites of veterinary importance. 1981. J.B. Walker

OP.3261/15/1/2: External parasites: systematics of the genus *Rhipicephalus*. 1973. J.B. Walker

PATHOLOGY/PATOLOGIE

OP.3261/19/1/1: External parasites: *Cowdria ruminantium* in *Amblyomma hebraeum*. 1977. J.D. Bezuidenhout

OP.3261/19/1/2: External parasites: multiplication of arboviruses in *Culicoides* spp. 1973. E.M. Nevill

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D.5135/35/1/13: A survey for the National Land Use Inventory in the Port Elizabeth Extension Ward. 1982. H.H.D. Lourens

D.5135/35/1/14: A survey for the National Land Use Inventory in the Uitenhage Extension Ward. 1982. L.O. Grobler

N.5135/35/1/1: Agriquest survey of land use and farming enterprises in Natal Region in 1979/80. 1979. P.J. Fotheringham

OTHER SURVEYS/ANDER OPNAMES

SITUATION ANALYSIS/SITUASIEBEPALING

D.5136/35/1/1: Other surveys: the animal husbandry situation in the reasonably homogeneous ecological areas (RHEs) of the eastern seaboard areas in the Eastern Cape. 1980. R.E.D. Bradfield

HK.5136/35/1/1: An investigation into woolled sheep farming in the Republic of South Africa. 1982. R.E.D. Bradfield

HK.5136/35/2/1: Other surveys: an investigation into factors inhibiting the adoption of recommended veld management practices in the recognised grazing areas of the RSA. 1984. C.H. de Klerk

POTENTIAL STUDIES/POTENSIAALSTUDIES

HK.5136/36/1/1: Other surveys: agricultural development plan for Rehoboth Gebiet. 1982. C.H. de Klerk

EXTENSION SCIENCE/VOORLIGTINGKUNDE

HK.5136/40/1/1: Other surveys: an investigation into the efficiency of study groups in Transvaal. 1984. C.H. de Waal

Irrigation development/Besproeiingsontwikkeling

IRRIGATION PLANNING/BESPROEIINGSBEPLANNING

EVALUATION/EVALUASIE

GB.5141/37/1/1: Evaluation of areas for irrigation development and farm layout on State Schemes. 1979. J.A. Stofberg

GB.5141/37/1/2: Evaluation of existing irrigation schemes. 1982. J.A. Stofberg

RESOURCE UTILISATION RESEARCH (CROPS)/HULPBRON-BENUTTINGSNAVORSING (GEWASSE)

Bushveld areas/Bosveldgebiede

SUMMER GRAIN/SOMERGRAAN

PESTS/PLAE

T.5211/20/1/1: Summer grain: survey of fungus-growing termites on agronomic crops in the bushveld of the Transvaal Region. 1977. H.H. Gouse

Summer rain cropping areas/Somerreënsaaigebiede

SUMMER GRAIN/SOMERGRAAN

NUTRITION/VOEDING

T.5221/05/1/1: Summer grain: the effect of phosphate fixation and aluminium toxicity on maize production in the summer rain cropping area. 1971. W.J. Conradie

T.5221/05/1/2: Summer grain: the inlfuence of rock phosphate and double superphosphate on optimum maize production in the summer rain cropping area of Transvaal. 1980. G.J. du Toit

T.5221/05/1/3: Summer grain: amelioration of soil acidity for optimum maize production in the summer rain cropping area of Transvaal. 1980. G.J. du Toit

T.5221/05/1/4: Summer grain: nitrogen, phosphorus and potassium fertilisation of maize in the summer rain cropping area of Transvaal. 1980. G.J. du Toit

T.5221/05/1/5: Summer grain: the comparison between hand-placed P at planting time and pre-planted ploughed-down P as regards optimum maize production in the summer rain cropping area of Transvaal. 1980. G.J. du Toit

T.5221/05/1/6: Summer grain: the influence of potassium on optimum maize production in the summer rain cropping area of Transvaal. 1980. G.J. du Toit

SMALL GRAIN/KLEINGRAAN

CROP SCIENCE/GEWASKUNDE

V.5222/30/1/1: Small grain: evaluation of minimum tillage and stubble mulch practices in a long fallow system of dryland wheat production at Sandvet in the summer rain cropping areas. 1984. C. Engelbrecht

OIL AND PROTEIN SEEDS/OLIE- EN PROTEïENSADE

NUTRITION/VOEDING

H.5223/05/1/1: Oil and protein seeds: the growth and yield of soybeans on a Bainsvlei/ Ottosdal soil in the summer rain cropping area as influenced by different phosphate levels. 1983. P.J. Laubscher

VEGETABLES AND TUBER CROPS/GROENTE EN KNOLGEWASSE

PESTS/PLAE

T.5224/20/1/1: Vegetables and tuber crops: the study of the biology of the black maize beetle on potatoes in the summer rain cropping area of the Transvaal Region. 1978. H.H. Gouse

Eastern seaboard areas/Oostelike kusgebiede

SUMMER GRAIN/SOMERGRAAN

CROP SCIENCE/GEWASKUNDE

D.5231/30/1/1: Summer grain: maize planting dates on an Oakleaf soil at Bathurst in the eastern seaboard of the Eastern Cape. 1979. R.S. Marr

D.5231/30/1/2: Summer grain: maize planting dates on a Hutton soil at Bathurst in the eastern seaboard of the Eastern Cape. 1979. R.S. Marr

SMALL GRAIN/KLEINGRAAN

CHEMICAL CONTROL/CHEMIESE BEHEER

W.5232/21/1/1: Chemical weed control of different broad leaf and grass weeds in small grain in the eastern seaboard of the Winter Rainfall Region. 1974. J.W. Loubser

W.5232/21/1/2: Small grain: the influence of chemical pre-emergence control of weeds in wheat on the grain yield. 1977. J.W. Loubser

CROP SCIENCE/GEWASKUNDE

W.5232/30/1/1: Small grain: the influence of the environment and crop manipulation on the yield of wheat in the eastern seaboard of the Winter Rainfall Region. 1974. B.J. Stander

W.5232/30/1/2: Small grain: soil cultivation techniques for optimum wheat production in the eastern seaboard. 1979. G.A. Agenbag

W.5232/30/1/3: Small grain: the evaluation of released wheat cultivars in respect of yield and quality in the eastern seaboard of the Winter Rainfall Region. 1974. B.J. Stander

SUBTROPICAL FRUITS AND CROPS/SUBTROPIESE VRUGTE EN GEWASSE

PERSUASION/OORREDING

N.5238/39/1/1: Subtropical fruits and crops: situation survey of banana production in the eastern seaboard areas of Natal Region. 1983. E.H. Gevers

High rainfall sourveld areas/Hoëreënsuurveldgebiede

SUMMER GRAIN/SOMERGRAAN

PHYSIOLOGY/FISIOLOGIE

N.5241/03/1/1: Summer grain: aluminium tolerance of maize cultivars in the high rainfall sourveld area. 1982. R.J. Bennet

NUTRITION/VOEDING

D.5241/05/1/1: Summer grain: NPK nutrition of maize at Dohne in the high rainfall sourveld areas of the Eastern Cape. 1979. R.S. Marr

D.5241/05/1/2: Summer grain: NPK nutrition of maize at Sternberg in the high rainfall sourveld areas of the Eastern Cape. 1979. R.S. Marr

D.5241/05/1/3: Summer grain: NP nutrition of maize at Sternberg in the high rainfall sourveld areas of the Eastern Cape. 1979. R.S. Marr

D.5241/05/1/4: Summer grain: nutrition of maize at Ugie in the high rainfall sourveld areas of the Eastern Cape. 1980. R.S. Marr

T.5241/05/1/1: Summer grain: the influence of rock phosphate and double superphosphate on optimum maize production in the high rainfall sourveld area of Transvaal. 1980. G.J. du Toit

T.5241/05/1/2: Summer grain: amelioration of soil acidity for optimum maize production in the high rainfall sourveld area of Transvaal. 1980. G.J. du Toit

T.5241/05/1/3: Summer grain: nitrogen, phosphorus and potassium fertilisation of maize in the high rainfall sourveld area of Transvaal. 1980. G.J. du Toit

T.5241/05/1/4: Summer grain: the comparison between hand-placed P at planting time and pre-planted ploughed-down P as regards optimum maize production in the high rainfall sourveld area of Transvaal. 1980. G.J. du Toit

T.5241/05/1/5: Summer grain: the influence of potassium on optimum maize production in the high rainfall sourveld area of Transvaal. 1980. G.J. du Toit

CROP SCIENCE/GEWASKUNDE

D.5241/30/1/1: Summer grain: maize planting dates at Dohne in the high rainfall sourveld areas of the Eastern Cape. 1979. R.S. Marr

POTENTIAL STUDIES/POTENSIAALSTUDIES

D.5241/36/1/1: The establishment of summer grain maize yield norms in the Sutterheim Extension Ward. 1980. P.G. King

VEGETABLES AND TUBER CROPS/GROENTE EN KNOLGEWASSE

PATHOLOGY/PATOLOGIE

N.5244/19/1/1: Vegetables and tuber crops: epidemiology and chemical control of potato early blight in the high rainfall sourveld area of Natal Region. 1982. W.G. Nevill

Central grassveld areas/Sentrale grasveldgebiede

SMALL GRAIN/KLEINGRAAN

CROP SCIENCE/GEWASKUNDE

V.5262/30/1/2: Small grain: evaluation of minimum tillage and stubble mulch practices in a long fallow system of dryland wheat production in the central grassveld areas at Glen. 1984. H.A. Smit

Karoo and arid areas/Karoo en ariede gebiede

SMALL GRAIN/KLEINGRAAN

CROP SCIENCE/GEWASKUNDE

W.5252/30/1/1: Small grain: the evaluation of released wheat cultivars in respect of yield and quality in the Karoo and arid areas of the Winter Rainfall Region. 1974. B.J. Stander

OTHER CROPS/ANDER GEWASSE

CROP SCIENCE/GEWASKUNDE

W.5259/30/1/1: Other crops: the adaptability and methods of cultivation of jojoba (*Simmondia chinensis*) in the Karoo and arid areas, Winter Rainfall Region. 1980. D.J. le Roux

Winter rain cropping areas/Winterreënsaaigebiede

SMALL GRAIN/KLEINGRAAN

NUTRITION/VOEDING

W.5272/05/1/1: Small grain: the influence of time of application of nitrogen fertiliser on wheat in the winter rain cropping area. 1981. B.J. Stander

PESTS/PLAE

W.5272/20/1/1: The identity and occurrence of aphids associated with small grain production in the winter rain cropping area. 1975. S.S. Walters

W.5272/20/1/2: The pest status of aphids associated with small grain in the winter rain cropping area. 1978. S.S. Walters

CHEMICAL CONTROL/CHEMIESE BEHEER

W.5272/21/1/1: Chemical weed control of different broad leaf and grass weeds in small grain production in the winter rain cropping area. 1974. J.W. Loubser

W.5272/21/1/2: Small grain: the influence of chemical pre-emergence control of weeds in wheat on the yield in the winter rain cropping area. 1977. J.W. Loubser

KLEINGRAAN

CROP SCIENCE/GEWASKUNDE

W.5272/30/1/1: Small grain: the evaluation of released wheat cultivars in respect of yield and quality in the winter rain cropping area. 1974. B.J. Stander

W.5272/30/1/2: Small grain: soil cultivation practices for optimum wheat production in the Swartland of the winter rain cropping area. 1975. G.A. Agenbag

W.5272/30/1/3: Small grain: the influence of crop requirements and environmental factors on the yield and quality of malting barley in the winter rain cropping area. 1974. B.J. Stander

W.5272/30/1/4: Small grain: soil cultivation techniques for optimum wheat production in the Ruens of the winter rain cropping area. 1976. G.A. Agenbag

W.5272/30/1/5: Small grain: the influence of the environment and crop manipulation on the yield of wheat in the winter rain cropping area. 1974. B.J. Stander

OIL AND PROTEIN SEEDS/OLIE- EN PROTEïENSADE

CROP SCIENCE/GEWASKUNDE

W.5273/30/1/1: Oil and protein seeds: the evaluation of cultivars of different species of lupins with respect to adaptability, disease resistance and yield, in the winter rain cropping area. 1958. H.J.C. Agenbag

VEGETABLE AND TUBER CROPS/GROENTE EN KNOLGEWASSE

PESTS/PLAE

W.5274/20/1/1: Vegetable and tuber crops: the migratory habits of aphid vectors of potato viruses in the seed potato-producing areas of the winter rain cropping area. 1975. S.S. Walters

OTHER CROPS/ANDER GEWASSE

CROP SCIENCE/GEWASKUNDE

W.5279/30/1/1: Other crops: a study of the adaptability and methods of cultivation of new crops in the winter rain cropping area. 1980. D.J. le Roux

Irrigation areas/Besproeiingsgebiede

SMALL GRAIN/KLEINGRAAN

CROP SCIENCE/GEWASKUNDE

V.5282/30/1/1: Small grain: irrigation and nitrogen fertilisation studies with wheat in the Lower Orange River area at Upington. 1983. C. Engelbrecht

V.5282/30/1/2: Small grain: irrigation and nitrogen fertilisation studies with wheat in the Vaalharts irrigation area. 1983. C. Engelbrecht

V.5282/30/1/3: Small grain: irrigation and nitrogen fertilisation studies with wheat grown in rotation with maize at the Vaalharts Research Station. 1984. C. Engelbrecht

RESOURCE UTILISATION RESEARCH (ANIMALS)/HULPBRON-BENUTTINGSNAVORSING (DIERE)

Bushveld areas/Bosveldgebiede

LARGE STOCK/GROOTVEE

PHYSIOLOGY/FISIOLOGIE

T.5311/03/1/1: Large stock: milk production of beef cattle in the sweet bushveld of Transvaal. 1948. C.J.F. Lüdemann

REPRODUCTION/REPRODUKSIE

V.5311/04/1/1: Large stock: an investigation on practical methods for shortening the intercalving period of Afrikaner cattle at Armoedsvlakte in the bushveld areas. 1979. J.A. Vermeulen

V.5311/04/1/2: Large stock: control of LH release during synchronised estrus of beef cows at Armoedsvlakte in the bushveld areas. 1979. J.A. Vermeulen

V.5311/04/1/3: Large stock: an investigation on the use of gonatrophic releasing hormone in the application of AI with beef cows at Armoedsvlakte in the bushveld areas. 1979. J.A. Vermeulen

NUTRITION/VOEDING

T.5311/05/1/1: Large stock: supplementary feeding of beef cattle with calves in the sweet bushveld of Transvaal Region. 1965. C.J.F. Lüdemann

T.5311/05/2/1: Large stock: supplementary feeding on sweet bushveld and finishing in pens of growing beef cattle. 1965. C.J.F. Lüdemann

T.5311/05/3/1: Large stock: the value of bush species and the survival of beef cattle in the bushveld areas. 1983. G.D. de Bruin

V.5311/05/1/1: Large stock: the evaluation of the nutritive value of veld with the aim at meat production at Vaalharts in the bushveld areas. 1974. E.A.N. Engels

UPGRADING/VEREDELING

T.5311/07/1/1: Large stock: comparison of pure and crossbred beef cattle in different breeding systems for the sweet bushveld. 1965. C.J.F. Lüdemann

T.5311/07/1/2: Large stock: development and upgrading of the Edelheer, Roodebos and Wesselsvlei breeding lines of the Bonsmara beef cattle race in the mixed bushveld at Roodeplaat. 1971. G. Marincowitz

V.5311/07/1/1: Large stock: the use of different beef cattle breeds as male and female breeding material in pure crossbreeding systems at Vaalharts in the bushveld areas. 1976. D.L. Els

V.5311/07/1/2: Large stock: crossbreeding with the Afrikaner cow with different large frame breeds in a semi-intensive production system at Vaalharts in the bushveld areas. 1973. D.L. Els

V.5311/07/1/3: Large stock: the production potential of female crosses from Afrikaner cows with different large frame beef breeds at Vaalharts in the bushveld areas. 1976. D.L. Els

V.5311/07/1/4: Large stock: evaluation of the Belmont red and Bonsmara beef breeds under extensive conditions in the bushveld areas at Vaalharts. 1982. D.L. Els

GROOTVEE

V.5311/07/2/1: Large stock: the development and upgrading of the Wesselsvlei strain at Armoedsvlakte in the bushveld areas. 1981. D.L. Els

MANAGEMENT/BESTUUR

T.5311/41/1/1: Large stock: beef cattle production on natural pasture in the bushveld supplemented with *Cenchrus ciliaris* on the Springbok Flats. 1973. E.E. Lademann

T.5311/41/1/2: Large stock: a stable beef cattle production system on mopaniveld in the bushveld. 1968. C.J.F. Lüdemann

T.5311/41/1/3: The potential and profit margins of weaner-, tollie- and ox-production systems in the bushveld of Transvaal. 1983. C.J.F. Lüdemann

SMALL STOCK/KLEINVEE

NUTRITION/VOEDING

V.5312/05/1/1: Small stock: the evaluation of the nutritive value of veld with the aim at mutton production at Koopmansfontein in the bushveld areas. 1973. E.A.N. Engels

UPGRADING/VEREDELING

D.5312/07/1/1: Small stock: a genetic evaluation of two improved Boer goat genotypes in the bushveld areas of the Eastern Cape. 1980. A.J. Fourie

K.5312/07/1/1: Small stock: selection for fleece properties and fertility of the Angora goat in the Karoo and bushveld area of the Karoo Region. 1966. C.M.M. Landman

V.5312/07/1/1: Small stock: a comparison of four selection criteria for increasing the production of Dorper sheep at Koopmansfontein in the bushveld areas. 1984. D.L. Els

MANAGEMENT/BESTUUR

T.5312/41/1/2: Small stock: production of Dorper sheep and Boer goats in the sour mixed bushveld where ewes are mated once per year. 1972. G. Marincowitz

V.5312/41/1/1: Small stock: the development of fat lamb production systems with Dorper sheep in the bushveld areas of the Free State Region at Koopmansfontein. 1983. D.L. Els

Summer rain cropping areas/Somerreënsaaigebiede

LARGE STOCK/GROOTVEE

NUTRITION/VOEDING

H.5321/05/1/2: Large stock: optimal summer utilisation of fertilised and unfertilised veld in the summer rain cropping areas with year-old steers. 1982. J.W. Cilliers

H.5321/05/3/1: Large stock: beef production from winter cereal pasture on a shallow Avalon soil in the eastern part of the summer rain cropping areas. 1979

H.5321/05/4/1: Large stock: preservation and protein stabilisation of maize silage in the summer rain cropping area. 1978. L.D. Snyman

H.5321/05/4/2: Large stock: the utilisation of ensiled mixtures of cattle manure and maize crop residues by large stock in the summer rain cropping area. 1983. L.D. Snyman

LARGE STOCK

H.5321/05/6/1: Large stock: utilisation of *Digitaria eriantha* ssp. *eriantha* as grazing crop by dairy cows in the summer rain cropping areas. 1979. Joretha G. Horn

H.5321/05/6/2: Large stock: milk production from winter cereal pastures on a shallow Avalon soil in the eastern part of the summer rain cropping areas. 1979

H.5321/05/6/3: Large stock: milk production of maize silage or pastures as sources of roughage for dairy cows in the summer rain cropping areas. 1984. Joretha G. Horn

H.5321/05/7/2: Large stock: the influence of different soybean flour, whey powder and colostrum-based milk replacers on post-weaning growth and veal production of dairy bull calves in the summer rain cropping area. 1982. C.W. Cruywagen

H.5321/05/8/1: Large stock: the utilisation of cultivated summer pastures by Friesland heifers from weaning up to six months of age in the summer rain cropping areas. 1985. Joretha G. Horn

T.5322/07/1/2: Small stock: evaluation of Merino F1 woolled sheep crosses as mother ewes for second-stage crossings in the summer rain cropping area. 1969. L. Ueckermann

. OTHER ANIMALS/ANDER DIERE

UPGRADING/VEREDELING

T.5325/07/1/1: Other animals: upgrading of the Nooitgedacht horse in the summer rain cropping area of Transvaal Region. 1951. D.W. Eden

Eastern seaboard areas/Oostelike kusgebiede

LARGE STOCK/GROOTVEE

NUTRITION/VOEDING

D.5331/05/1/1: Large stock: the evaluation of cultivated kikuyu pastures for milk production in the eastern seaboard of the Eastern Cape. 1984. W.P. Henning

D.5331/05/1/2: Large stock: the evaluation of cultivated kikuyu grass pastures for the growing-out of dairy heifers during summer in the eastern seaboard areas of the Eastern Cape Region. 1984. P.J. Olivier

W.5331/05/1/1: Large stock: evaluation of feeding practices for lactating dairy cows in the eastern seaboard areas. 1980. C.J.C. Muller

SMALL STOCK/KLEINVEE

NUTRITION/VOEDING

W.5332/05/1/1: Small stock: mineral deficiencies and supplementation thereof to mutton sheep on artificial pastures in the eastern seaboard areas. 1979. N.M. Kritzinger

MANAGEMENT/BESTUUR

D.5332/41/1/1: Small stock: integration of woolled mutton sheep in the eastern seaboard of the Eastern Cape. 1979. F.O.C.W. Karberg

W.5332/41/1/1: A comparison of two mating regimes with mutton sheep to improve small stock production in the George area of the eastern seaboard. 1979. S.W.P. van der M. Cloete

KLEINVEE

W.5332/41/1/2: Small stock: the use of plastic coats to cut down lamb mortality in the George area of the eastern seaboard of the Winter Rainfall Region. 1982. S.W.P. van der M. Cloete

High rainfall sourveld areas/Hoëreënsuurveldgebiede

LARGE STOCK/GROOTVEE

PHYSIOLOGY/FISIOLOGIE

D.5341/03/1/1: Large stock: hormonal status and calving percentage of cows and heifers in the high rainfall sourveld areas of the Eastern Cape. 1979. J.A. Erasmus

D.5341/03/1/2: Large stock: calving percentage and protein status of cows in the high rainfall sourveld areas of the Eastern Cape. 1981. J.A. Erasmus

H.5321/05/8/2: Large stock: the utilisation of cultivated winter pastures by Friesland heifers from weaning up to six months of age in the summer rain cropping areas. 1985. Joretha G. Horn

UPGRADING/VEREDELING

H.5321/07/1/1: Large stock: the influence of genetic and environmental factors on production traits of an Afrikaner cattle herd in the summer rain cropping area. 1983. J.J. Viljoen

SMALL STOCK/KLEINVEE

PHYSIOLOGY/FISIOLOGIE

T.5322/04/1/1: Small stock: effect of energy protein and NPN on the fertility of mutton sheep ewes in the summer rain cropping area. 1970. G. Marincowitz

T.5322/04/2/1: Small stock: the sexual activity of Merino woolled sheep and their crosses in the summer rain cropping area. 1973. L. Ueckermann

NUTRITION/VOEDING

H.5322/05/1/1: Small stock: the potential of *Digitaria eriantha* ssp. *eriantha* as summer grazing crop for woolled sheep in the summer rain cropping area. 1982. B.G.J. van Vuuren

H.5322/05/1/2: Small stock: wintering of woolled sheep on *Digitaria eriantha* ssp. *eriantha* as foggage in the summer rain cropping area. 1983. B.G.J. van Vuuren

H.5322/05/2/1: Small stock: slaughter lamb production from winter cereal grazing in the eastern part of the summer rain cropping areas. 1978. J.W. Cilliers

H.5322/05/2/2: Small stock: intake and feeding value of *Triticale* and rye grass pasture for slaughter lambs in the eastern part of the summer rain cropping area. 1980. J.W. Cilliers

H.5322/05/3/1: Small stock: the effect of the ratio of cattle manure to maize crop residue on the feeding value of ensiled cattle manure: maize crop residue mixtures in the summer rain cropping areas. 1979. L.D. Snyman

H.5322/05/3/2: Small stock: the feeding value of maize crop residue from summer rain cropping areas in comparison with that of *Eragrostis curvula* hay as feed for small stock. 1982. L.D. Snyman

SMALL STOCK

T.5322/05/1/1: Small stock: the chemical composition and digestibility of the whole maize plant and its components in the summer rain cropping area of Transvaal. 1982. H.M.I. Schoonraad

T.5322/05/1/2: Small stock: the effect of different harvest dates on the chemical composition digestibility and dry matter production of the maize plant and its components in the summer rain cropping area of Transvaal. 1982. H.M.I. Schoonraad

T.5322/05/1/3: Small stock: the effect of nitrogen fertilisation on the chemical composition, digestibility and dry matter production of the maize plant and its components in the summer rain cropping area of Transvaal. 1982. H.M.I. Schoonraad

T.5322/05/1/4: Small stock: the evaluation of the maize plant as a component of a finishing ration in the summer rain cropping area of Transvaal. 1982. H.M.I. Schoonraad

UPGRADING/VEREDELING

T.5322/07/1/1: Small stock: evaluation of Merino woolled sheep and F1 crosses under intensive conditions in the summer rain cropping area. 1969. L. Ueckermann

T.5341/03/1/1: Large stock: influence of different over-wintering feeding regimes on the reproduction and growth of beef cattle in the high rainfall sourveld area. 1971. P. Langenegger

REPRODUCTION/REPRODUKSIE

N.5341/04/1/1: Large stock: the effect of pre-partum feeding levels and target mass at mating on reproduction in female beef cattle in the high rainfall sourveld of Natal Region. 1979. A.P. van Schalkwyk

N.5341/04/1/2: Large stock: oestrus and ovulation in mature female beef cattle as affected by changes in live mass in the high rainfall sourveld of Natal Region. 1978. B.P. Louw

N.5341/04/1/3: Large stock: influence of restricted suckling on the reproductive performance of beef cattle cows in the high rainfall sourveld of Natal Region. 1980. B.P. Louw

N.5341/04/1/4: Large stock: reproduction in the beef female as influenced by bull libido in the high rainfall sourveld area at Dundee. 1983. J.S. Crichton

NUTRITION/VOEDING

D.5341/05/1/1: Large stock: monensin sodium in licks for beef cattle in the high rainfall sourveld areas of the Eastern Cape. 1979. W.P. Henning

D.5341/05/2/2: Large stock: the evaluation of alkali-treated whole-shelled maize in dairy cow rations in the high rainfall sourveld areas of the Eastern Cape Region. 1984. W.P. Henning

D.5341/05/3/1: Large stock: a study of the seasonal variation of the beta carotene content of sourveld and its effect on blood plasma levels of beef cows in the high rainfall sourveld area of the Eastern Cape. 1983. R.E.D. Bradfield

D.5341/05/3/2: Large stock: the effect of levels of beta carotene supplementation on the reproduction of beef cows in the high rainfall sourveld area of the Eastern Cape. 1983. R.E.D. Bradfield

N.5341/05/1/1: Large stock: the chemical composition and nutritive value of veld for beef cattle in Bio-regions 3 and 4 in the high rainfall sourveld of Natal Region. 1971. R.M. Bredon

N.5341/05/1/2: Large stock: effect of stocking rates and lick supplementation on beef cattle performance in the high rainfall sourveld of Natal Region. 1975. A. van Niekerk

KLEINVEE

N.5341/05/2/1: Large stock: evaluation of *Eragrostis curvula* silage ensiled at the hay-cutting stage for wintering replacement beef cattle heifers in the high rainfall sourveld of Natal Region. 1981. A. van Niekerk

N.5341/05/2/3: Large stock: utilisation of maize residues by pregnant beef cows in the high rainfall sourveld areas at Dundee. 1965. J.S. Crichton

N.5341/05/3/1: Large stock: chemical composition and nutritive value of kikuyu pasture for lactating dairy cattle in the high rainfall sourveld of Natal Region. 1972. R.M. Bredon

N.5341/05/3/2: Large stock: chemical composition and nutritive value of tall fescue pasture for lactating dairy cattle in the Natal mist belt in the high rainfall sourveld of Natal. 1980. R.M. Bredon

N.5341/05/4/1: Large stock: utilisation of urea by lactating dairy cattle cows when fed on maize silage in the high rainfall sourveld of Natal Region. 1977. R.M. Bredon

UPGRADING/VEREDELING

D.5341/07/1/1: Large stock: genetic improvement of the Edelheer and Roodebos Bonsmara breed strains in the high rainfall sourveld areas of the Eastern Cape. 1980. A.J. Fourie

D.5341/07/1/2: Large stock: performance testing of bulls from the Edelheer and Roodebos Bonsmara strains in the high rainfall sourveld areas of the Eastern Cape. 1980. J.P. Compaan

T.5341/05/1/1: Large stock: supplementary feeding of growing beef cattle in the high rainfall sourveld. 1971. D.W. Eden

MANAGEMENT/BESTUUR

N.5341/41/1/1: Large stock: the effect of origin of beef cattle on subsequent growth and performance in the high rainfall sourveld of Natal Region. 1963. S.F. Lesch

N.5341/41/1/3: Large stock: effect of winter growth levels and stocking rates on high rainfall sourveld on the development of beef cattle heifers in Natal Region. 1981. A. van Niekerk

N.5341/41/1/4: Large stock: the influence of stocking rate on the reproduction performance of beef cows and on the veld in the high rainfall sourveld, 4f, of Natal Region. 1982. A.D. Lyle

N.5341/41/2/1: Large stock: performance of dual purpose and British beef cattle on kikuyu pasture in the high rainfall sourveld areas of Natal Region. 1976. B.P. Louw

N.5341/41/2/2: Large stock: beef production on *A. macrum* and *D. eriantha* in Bioclimatic Region 8 of the high rainfall sourveld areas of Natal Region. 1983. A.P. Schalkwyk

N.5341/41/3/1: Large stock: effect of shade upon milk production of lactating dairy cattle grazing summer pasture in the high rainfall sourveld areas of Natal Region. 1981. T.J. Dugmore

N.5341/41/3/2: Large stock: data bank for the dairy cattle herd on Cedara in the high rainfall sourveld areas of Natal Region. 1981. T.J. Dugmore

SMALL STOCK/KLEINVEE

REPRODUCTION/REPRODUKSIE

N.5342/04/1/1: Small stock: subnormal luteal function in ewes after seasonal anoestrus in the high rainfall sourveld areas in Natal Region. 1980. J. Grobbelaar

NUTRITION/VOEDING

D.5432/05/1/1: Small stock: monensin sodium protein energy licks for woolled sheep ewe lambs in the high rainfall sourveld of the Eastern Cape. 1979. W.P. Henning

D.5342/05/1/2: Small stock: the effect of a winter nutritional stress on the production response of Merino wethers in the high rainfall sourveld areas of the Eastern Cape. 1983. R.E.D. Bradfield

D.5342/05/1/3: Small stock: the influence of stocking rate, whole grain feeding and rumen buffers on the production responses of ewes and lambs in the high rainfall sourveld of the Eastern Cape. 1983. W.P. Henning

D.5342/05/2/1: Small stock: a study of the seasonal variation of the beta carotene content of sourveld and its effect on blood plasma levels of woolled sheep ewes in the high rainfall sourveld area of the Eastern Cape. 1983. R.E.D. Bradfield

D.5342/05/2/2: Small stock: the effect of levels of beta carotene supplementation on the reproduction of woolled sheep ewes in the high rainfall sourveld area of the Eastern Cape. 1983. R.E.D. Bradfield

D.5342/05/3/1: Small stock: the influence of reproduction on nutrient selection and intake by woolled sheep in the high rainfall sourveld areas of the Eastern Cape. 1983. P.J.L. Zeeman

N.5342/05/1/1: Small stock: influence of phosphorus supplementation to a woolled sheep breeding flock in the high rainfall sourveld of Natal Region. 1976. A.D. Lyle

N.5342/05/2/1: Small stock: ensilaging of kikuyu for winter feeding of woolled sheep in the high rainfall sourveld of Natal Region. 1970. S.F. Lesch

N.5342/05/3/1: Small stock: lamb growth and milk production of the ewe on Italian rye grass in the high rainfall sourveld of Natal Region. 1982. W.A. Botha

T.5342/05/1/1: Small stock: chemical composition and digestibility of veld in the high rainfall sourveld as selected by fistulated woolled sheep. 1972. D.W. Eden

T.5342/05/2/1: Small stock: creeping feeding and early weaning of woolled sheep in the high rainfall sourveld of South-eastern Transvaal. 1972. M.J. Bekker

T.5342/05/2/2: Small stock: supplementary of pregnant woolled sheep in the high rainfall sourveld of South-east Transvaal. 1972. M.J. Bekker

T.5342/05/2/3: Small stock: voluntary intake of urea and molasses-treated *Eragrostis curvula* hay in different physical forms by woolled sheep in the high rainfall sourveld. 1972. M.J. Bekker

T.5342/05/2/4: Small stock: a comparison of NPN and natural protein in winter licks to woolled sheep on rested veld in the high rainfall sourveld areas. 1981. M.J. Bekker

T.5342/05/2/5: Small stock: improved utilisation of dryland lucerne in the high rainfall sourveld for slaughter lamb production by means of maize grain supplementation. 1984. H.M.I. Schoonraad

MANAGEMENT/BESTUUR

N.5342/41/1/1: Three intensive fat lamb production systems for the high rainfall sourveld in Natal Region. 1974. J. Grobbelaar

N.5342/41/2/1: Small stock: comparison of three lambing periods; spring, late summer and autumn, with Merino sheep in the high rainfall sourveld areas, Bioclimatic subregion 4f of Natal. 1984. A.D. Lyle

Karoo and arid areas/Karoo en ariede gebiede

SMALL STOCK/KLEINVEE

PHYSIOLOGY/FISIOLOGIE

K.5352/03/2/2: Small stock: effect of cold on abortion in the Angora goat in the Karoo and arid areas. 1975. D. Wentzel

K.5352/03/2/4: Small stock: relationship of hormone levels in the Angora goat kid to subsequent reproductive potential of the mature ewe in the Karoo and arid areas. 1976. D. Wentzel

V.5352/04/1/1: Small stock: the influence of season of birth on puberty semen production and LH levels of Karakul rams at the Karakul Research Station in the Karoo and arid areas. 1979. A.S. Faure

V.5352/04/1/2: Small stock: the influence of nutrition and estrogens on the reproduction of young Karakul ewes at the Karakul Research Station in the Karoo and arid areas. 1980. A.S. Faure

NUTRITION/VOEDING

K.5352/05/1/1: Small stock: digestibility of three *Atriplex* species with sheep in the Karoo and arid areas. 1976. F.C. Hayward

K.5352/05/1/2: Small stock: chemical composition and digestibility of *Atriplex nummularia* selected by sheep in the Karoo and arid areas. 1979. F.C. Hayward

K.5352/05/1/3: Small stock: determination of optimal levels of supplementation to lactating Merino ewes on *Atriplex nummularia* in the Karoo and arid areas. 1980. F.C. Hayward

K.5352/05/2/1: Small stock: voluntary intake, digestibility and chemical composition of veld as selected by small stock in the Karoo and arid areas. 1974. P.J.L.R. Zeeman

K.5352/05/2/2: Small stock: influence of energy and protein supplementation with and without phosphorus and different Karoo pastures for sheep production in the Karoo and arid areas. 1977. F.C. Hayward

K.5352/05/2/3: Small stock: the influence of feeding additional energy to Angora goats grazing succulent mountain shrub veld of the Karoo and arid areas. 1982. C.M.M. Landman

K.5352/05/2/4: Small stock: determination of the optimal level of energy supplementation to dry Angora goats on chopped noors in the Karoo and arid area. 1983. C.M.M. Landman

K.5352/05/3/1: Small stock: body composition and nutrient requirements of Dorper sheep for growth in the Karoo and arid areas. 1976. P.G. Marais

K.5352/05/3/2: Small stock: determination of optimum level of urea addition to chocolate mealies for Angora goats in the Karoo and arid areas. 1983. V. Gevers

K.5352/05/3/3: Small stock: the determination of the minimum inclusion rate of roughages in a chocolate maize ration fed for the fattening of woolled sheep in a feedlot in the Karoo and arid areas. 1983. A.W.D. Kotze

K.5352/05/4/1: Small stock: utilisation of *Phragmites australis* in the flowering stage as roughage for woolled sheep in the Karoo and arid areas. 1983. J.P. Swiegers

V.5352/05/1/1: Small stock: a study of the influence of phosphorus status on the production and reproduction of Karakul ewes on veld of the Karakul Research Station in the Karoo and arid areas. 1981. A.S. Faure

SMALL STOCK

V.5352/05/1/2: Small stock: the influence of nutrition during pregnancy on the pelt quality of Karakul lambs in the Karoo and arid areas at the Karakul Research Station. 1982. A.S. Faure

UPGRADING/VEREDELING

K.5352/07/1/2: Small stock: half-classing as a method of selection for Merino sheep in the Karoo and arid areas. 1965. J.A.A. Baard

K.5352/07/1/3: Small stock: comparison of different methods of selection with Merino sheep in the Karoo and arid areas. 1962. J.J. Olivier

K.5352/07/1/4: Small stock: development of a white-woolled mutton sheep for the Karoo and arid areas. 1969. J.J. Olivier

K.5352/07/2/1: Small stock: selection for meat production and fertility in Dorper sheep in the Karoo and arid areas. 1977. P.G. Marais

K.5352/07/2/2: Small stock: the slaughter and carcass characteristics of Afrino x Merino lambs in comparison to that of the parent breeds of the Afrino in the Karoo and arid areas. 1983. J.J. Olivier

K.5352/07/2/3: Small stock: the conserving and maintaining of a Namakwa Afrikaner flock in the Karoo and arid areas. 1983. J.J. Olivier

V.5352/07/1/1: Small stock: development of a specific grey brown and silvery tipped chocolate brown pelt in Karakul sheep at the Karakul Research Station. 1962. A.S. Faure

V.5352/07/1/2: Small stock: selection lines in Karakul sheep at the Karakul Research Station. 1963. A.S. Faure

TECHNOLOGY/TEGNOLOGIE

K.5352/52/1/1: Small stock: weathering of wool in the Karoo and arid areas. 1976. J.J. Venter

K.5352/52/1/3: Small stock: effects of age on the production and quality aspects of mohair in the Karoo and arid areas. 1978. J.J. Venter

K.5352/52/1/4: Small stock: the influence of feeding additional energy on the production and quality of mohair produced by Angora ewes grazing on succulent mountain shrub veld of the Karoo and arid areas. 1982. P.D. Grobbelaar

K.5352/52/1/5: Small stock: the influence of feeding additional energy together with chopped noors on the quantity and quality of mohair produced by dry Angora goats in the Karoo and arid areas. 1983. P.D. Grobbelaar

OSTRICHES/VOLSTRUISE

REPRODUCTION/REPRODUKSIE

W.5353/04/1/1: The influence of copper, zinc and manganese injected subcutaneously, on the reproduction of ostriches at Oudtshoorn in the Karoo and arid areas. 1980. D. Swart

W.5353/04/2/1: Ostriches: the effect of season and rest period on reproduction performance in the Karoo and arid areas in the Winter Rainfall Region. 1984. D. Swart

NUTRITION/VOEDING

W.5353/05/1/1: The utilisation of caustic soda-treated wheat straw (4%) by the ostrich in the Karoo and arid areas at Oudtshoorn. 1982. C.J. Nel

W.5353/05/2/1: The influence of diet proteins and energy levels on the growth and feather production of slaughter ostriches in the Karoo and arid areas. 1981. D. Swart

KLEINVEE

W.5353/05/2/2: Ostrich nutrition: finishing of slaughter ostriches for optimal leather production above 75 kg live mass in the Karoo and arid areas. 1984. D. Swart

W.5353/05/3/1: Ostriches: the use of metabolisable energy (ME) as a measurement to evaluate feed stuffs for ostriches in the Karoo and arid areas. 1985. D. Swart

UPGRADING/VEREDELING

W.5353/07/1/1: Flock averages within a closed ostrich population, the interpretation thereof and the determination of possible genetic parameters - Karoo and arid areas. 1974. D. Swart

MANAGEMENT/BESTUUR

W.5353/41/1/1: Testing of chicken shelters for semi-intensive rearing of ostrich chickens in the Karoo and arid areas. 1982. D. Swart

W.5353/41/2/1: Ostriches: the micro-habitat of ostrich eggs during natural incubation in nests and under conditions of artificial incubation in the Karoo and arid areas of the Winter Rainfall Region. 1984. D. Swart

Central grassveld areas/Sentrale grasveldgebiede

LARGE STOCK/GROOTVEE

NUTRITION/VOEDING

D.5361/05/1/1: Large stock: the influence of reproduction or nutrient selection and intake by beef cattle in the central grassveld area of the Eastern Cape Region. 1983. P.J.L. Zeeman

V.5361/05/1/3: Large stock: the application of cultivated roughages for milk production at Glen. 1978. S.W. Matthee

V.5361/05/1/4: Large stock: the influence of frequency of concentrate feeding on the utilisation of roughage by dairy cows at Glen in the central grassveld area. 1983. S.W. Matthee

SMALL STOCK/KLEINVEE

NUTRITION/VOEDING

D.5362/05/1/1: Small stock: the influence of reproduction on nutrient selection and intake by woolled sheep in the central grassveld areas of the Eastern Cape Region. 1983. P.J.L. Zeeman

V.5362/05/1/1: Small stock: intake and digestibility studies with woolled sheep on cultivated winter and summer pastures at Glen in the central grassveld areas. 1982. E.A.N. Engels

V.5362/05/1/2: Small stock: the voluntary intake and digestibility of roughages by sheep at Glen in the central grassveld areas. 1964. E.A.N. Engels

V.5362/05/1/3: Small stock: the influence of different levels of protein and energy supplements to lactating ewes on veld at Glen in the central grassveld areas. 1979. H.O. de Waal

V.5362/05/1/4: Small stock: the influence of salt (NaCl) on the function of the rumen and the performance of sheep on veld of Glen in the central grassveld areas. 1981. H.O. de Waal

SMALL STOCK

V.5362/05/1/5: Small stock: the influence of salt (NaCl) on the function of the rumen and the performance of reproducing sheep in the central grassveld at Glen. 1983. H.O. de Waal

Winter rain cropping areas/Winterreënsaaigebiede

LARGE STOCK/GROOTVEE

NUTRITION/VOEDING

W.5371/05/1/1: Large stock: artificial kikuyu pastures as a source of food for dairy cattle cows in the winter rain cropping area. 1980. P.J. Swart

MANAGEMENT/BESTUUR

W.5371/41/1/1: Large stock: evaluation of shelters for dairy cattle cows in the winter rain cropping area. 1981. C.J.C. Muller

W.5371/41/2/1: Large stock management: the determination of the mastitis incidence using a fossomatic somatic cell counter and its value in mastitis management programmes in dairy cattle in the winter rain cropping area. 1984. J.G. Conradie

SMALL STOCK/KLEINVEE

NUTRITION/VOEDING

W.5372/05/1/1: Small stock: the treatment of wheat straw with ureum and its utilisation by sheep during the summer time in the winter rain cropping area. 1981. S.W.P. van der M. Cloete

W.5372/05/2/1: The nutritional value of *Medicago truncatula* (cultivar Jemalong) for sheep in the winter rain cropping area. 1979. T.T. de Villiers

PIGS/VARKE

NUTRITION/VOEDING

W.5374/05/1/3: Pigs: evaluation of barley as feed source in pig diets in the winter rain cropping areas. 1983. R.C. Olckers

W.5374/05/2/1: Pigs: effect of pre-weaning creep intake and growth performance on subsequent production performance of pigs in the winter rain cropping areas. 1983. N.M. Kritzinger

Irrigation areas/Besproeiingsgebiede

SMALL STOCK/KLEINVEE

NUTRITION/VOEDING

K.5382/05/1/1: Small stock: utilisation and management of lucerne production in the Fish River irrigation area of the Karoo Region. 1979. A.G. Bezuidenhout

K.5382/05/1/2: Small stock: fodder crop utilisation with Merino sheep in the Fish River irrigation area. 1982. A.G. Bezuidenhout

VELD

W.5382/05/1/1: Small stock: trace-element deficiencies and supplementation of sheep on kikuyu pastures under irrigation in the Stellenbosch area. 1983. N.M. Kritzinger

OSTRICHES/VOLSTRUISE

MANAGEMENT/BESTUUR

W.5383/41/1/1: Ostriches: a comparison between meal feeding plus irrigated pastures in rearing systems for ostrich chicks in the irrigation area of the Winter Rainfall Region. 1984. D. Swart

RESOURCE UTILISATION RESEARCH (PASTURES)/HULPBRON-BENUTTINGSNAVORSING (WEIDING)

Bushveld areas/Bosveldgebiede

VELD

NUTRITION/VOEDING

T.5411/05/1/1: Veld: fertiliser trial on veld pasture in the bushveld area at Towoomba. 1949. G.T. Rootman

CHEMICAL CONTROL/CHEMIESE BEHEER

V.5411/21/1/1: Veld: a study of the effect of Graslan on the vegetation of the bushveld of the Northern Cape at De Woud. 1983. A. Moore

ECOLOGY/EKOLOGIE

T.5411/27/1/1: Veld: secondary succession on bare mopani veld pastures in the bushveld. 1964. C.H. Donaldson

SITUATION ANALYSIS/SITUASIEBEPALING

T.5411/35/1/1: Veld: the effects of different management practices on the natural veld of the bushveld in the Thabazimbi area. 1981. D. Grossman

POTENTIAL STUDIES/POTENSIAALSTUDIES

D.5411/36/1/1: Veld: the browsing capacity of the Valley Bushveld situated in the bushveld areas of the Eastern Cape Region. 1984. A.J. Aucamp

T.5411/36/1/1: Veld: the biomass dynamics of the most important grass species on debushed and non-debushed *Combretum* veld pastures in the bushveld. 1981. P.J. van der Merwe

T.5411/36/1/2: Veld: production potential and quality of debushed and non-debushed *Combretum* veld pastures in the bushveld. 1981. P.J. van der Merwe

T.5411/36/1/3: Veld: experimental cattle ranch on veld pastures in the bushveld at Soutpan. 1964. G. Marincowitz

V.5411/36/1/1: Veld: fixing of norms to determine carrying capacity on natural veld in the bushveld area at Armoedsvlakte. 1977. J.H. Fourie

V.5411/36/1/2: Veld: the monitoring of the effect of game on veld in the bushveld areas of the Free State Region in the Leon Taljaard Nature Reserve at Vryburg. 1983. J.H. Fourie

V.5411/36/1/3: Veld: the determination of norms for the estimation of the carrying capacity of *Tarchonanthus* veld for Dorper sheep in the bushveld areas of the Free State Region at Koopmansfontein. 1985. J.H. Fourie

MANAGEMENT/BESTUUR

T.5411/41/1/1: Veld: continuous and fixed seasonal rotational grazing systems for veld pastures in the bushveld. 1935. C.H. Donaldson

CULTIVATED PASTURE/AANGEPLANTE WEIDING

NUTRITION/VOEDING

V.5413/05/1/1: Cultivated pasture: determination of fertiliser requirements of *Anthephora pubescens* in terms of N, P and K on a soil of the Mangano series in the bushveld areas of the Free State Region. 1976. J.H. Fourie

V.5413/05/1/2: Cultivated pasture: an investigation of the nutritional requirements of *Panicum maximum* Jacq cv. Sabi in sand and soil cultures at Glen. 1983. L.G. du Pisani

V.5413/05/1/3: Cultivated pasture: an investigation on the nutritional requirements of *Anthephora pubescens* in sand and soil cultures in the bushveld areas of the Free State Region. 1983. L.G. du Pisani

V.5413/05/1/4: Cultivated pasture in the bushveld areas: the effect of soil pH and fertilisation on the production, digestibility and chemical composition of *P. maximum* Jacq cv. Sabi in soil cultures at Glen. 1983. L.G. du Pisani

V.5413/05/1/5: Cultivated pasture in the bushveld areas: the effect of soil pH and fertilisation on the production, digestibility and chemical composition of *Anthephora pubescens* Nees (VH20) in soil cultures at Glen. 1983. L.G. du Pisani

CROP SCIENCE/GEWASKUNDE

V.5413/30/1/1: Cultivated pasture: phase-1 evaluation of pasture plants in the bushveld areas of the Free State Region. 1974. J.H. Fourie

POTENTIAL STUDIES/POTENSIAALSTUDIES

T.5413/36/1/1: Cultivated pasture: dry matter production and nutritional value of *Stoloniferous digitaria* introduction in the bushveld. 1975. G.T. Rootman

T.5413/36/1/2: Cultivated pasture: dry matter production and nutritional value of *Panicum maximum* introductions in the bushveld. 1975. G.T. Rootman

T.5413/36/1/3: Cultivated pasture: performance of *Cenchrus ciliaris* as a summer pasture in the bushveld. 1972. G.T. Rootman

V.5413 36/1/2: Cultivated pasture: an ecotype evaluation of *Anthephora pubescens* at two fertilisation levels of soils of the Annandale series in the bushveld areas in the Free State Region. 1976. J.H. Fourie

V.5413 36 1/3: Cultivated pasture: an ecotype evaluation of *Anthephora pubescens* at two fertilisation levels on a soil of the Sunbury series at Vergeleë in the bushveld areas. 1983. J.H. Fourie

LUCERNE/LUSERN

CROP SCIENCE/GEWASKUNDE

V.5414/30/1/1: Lucerne: an investigation of the adaptability of lucerne cultivars which are resistant to the blue-green aphid and pea aphid under irrigation at Vaalharts. 1982. J.P. van Niekerk

ANNUAL FODDER CROPS/EENJARIGE VOERGEWASSE

POTENTIAL STUDIES/POTENSIAALSTUDIES

T.5415/36/1/1: Annual fodder crops: potential of other grasses as bushveld grazing crop. 1977. G.T. Rootman

Summer rain cropping areas/Somerreënsaaigebiede

VELD

ECOLOGY/EKOLOGIE

H.5421/27/1/1: Veld: the botanical composition of the vegetation on different veld units in the summer rain cropping area. 1983. A.S. Kruger

H.5421/27/1/2: Plant species preference of cattle on the different veld units in the summer rain cropping area. 1983. A.S. Kruger

H.5421/27/1/3: Veld: growth curves of certain preferred grasses on different veld units in the summer rain cropping area. 1983. A.S. Kruger

H.5421/27/1/4: Veld: patterns of plant succession on different veld units in the summer rain cropping area. 1983. A.S. Kruger

H.5421/27/2/1: Quantitative characterisation of veld and ecotypes in the summer rain cropping areas. 1984. R.H. Drewes

CROP SCIENCE/GEWASKUNDE

H.5421/30/1/1: Veld: growth and development of *Pachystigma pygmaeum* as a component of the veld in the summer rain cropping area. 1971. R.H. Drewes

T.5421/30/1/1: Veld: fertilisation of veld pastures in the north-eastern summer rain cropping area. 1969. N.F.G. Rethman

MANAGEMENT/BESTUUR

H.5421/41/1/2: Veld: evaluation of the productivity of the veld by means of changes in mass of animals grazing for various periods in the summer rain cropping areas. 1971

H.5421/41/1/4: Veld: management of veld in the summer rain cropping areas when infested with *Pachystigma pygmaeum*. 1974

T.5421/41/1/1: Veld: influence of winter defoliation of the grass sward of sourveld pastures in the summer rain cropping area of South-eastern Transvaal. 1968. N.F.G. Rethman

RADICAL VELD IMPROVEMENT/RADIKALE VELDVERBETERING

CROP SCIENCE/GEWASKUNDE

H.5422/30/1/1: Radical veld improvement: nursery evaluation of crops that can be used for radical veld improvement in the summer rain cropping areas. 1969. R.H. Drewes

*H.5422/30/1/3: Radical veld improvement: the value of different pasture crops on radically improved veld for milk production. 1977. R.H. Drewes

*H.5422/30/1/4: Radical veld improvement: the value of different pasture crops and radically improved veld for sheep in the eastern summer rain cropping areas. 1977. R.H. Drewes

T.5422/30/1/1: Radical veld improvement: introduction of rhizomatous grasses into the veld of summer rain cropping area of the South-eastern Transvaal. 1968. N.F.G. Rethman

T.5422/30/1/2: Radical veld improvement: establishment of perennial subtropical legume introductions into the natural veld of the summer rain cropping area of South-eastern Transvaal. 1974. N.F.G. Rethman

POTENTIAL STUDIES/POTENSIAALSTUDIES

T.5422/36/1/1: Radical veld improvement: comparison of subtropical legume- (*Vigna vexillata*) reinforced veld with natural veld for autumn grazing by sheep in the summer rain cropping area. 1973. N.F.G. Rethman

CULTIVATED PASTURE/AANGEPLANTE WEIDING

NUTRITION/VOEDING

T.5423/05/1/1: Cultivated pasture: distribution of phosphatic fertiliser on *Eragrostis curvula* in the Drakensberg grazing region of the summer rain cropping area. 1971. N.F.G. Rethman

T.5423/05/1/2: Cultivated pasture: comparison of hay, feeding practices in the evaluation of "feedback" on *Eragrostis curvula* hay pastures in the Drakensberg grazing region of the summer rain cropping area. 1973. N.F.G. Rethman

CROP SCIENCE/GEWASKUNDE

H.5423/30/1/3: Cultivated pasture: nursery evaluation of *Digitaria* spp. as cultivated pasture in the summer rain cropping areas of the Highveld Region. 1958. R.H. Drewes

H.5423/30/1/4: Cultivated pasture: relative value of Smuts finger grass and weeping love grass as cultivated pastures in the summer rain cropping areas. 1977

H.5423/30/2/3: Cultivated pasture: the value of Smuts finger grass (*Digitaria eriantha*) in combination with lucerne (SA standard) as a cultivated pasture in the summer rain cropping areas. 1981. R.H. Drewes

T.5423/30/1/1: Cultivated pasture: height and stage of cutting of *Eragrostis curvula* in the Drakensberg grazing region of the summer rain cropping area. 1969. N.F.G. Rethman

T.5423/30/1/2: Cultivated pasture: influence of burning, nitrogen and height of cutting on the seed production of *Eragrostis curvula* in Transvaal Region. 1973. N.F.G. Rethman

*Facet terminated/Faset gestaak

EENJARIGE VOERGEWASSE

T.5423/30/2/1: Cultivated pasture: seed multiplication of tropical and subtropical legumes and grasses. 1975. N.F.G. Rethman

POTENTIAL STUDIES/POTENSIAALSTUDIES

T.5423/36/1/1: Cultivated pasture: the influence of level of fertilisation and harvest stage on the feeding value of *Eragrostis curvula* hay in the Drakensberg grazing region of the summer rain cropping area. 1976. N.F.G. Rethman

T.5423/36/1/2: Cultivated pasture: determination of the production potential of grasses for irrigated pastures in the summer rain cropping area. 1973. N.F.G. Rethman

T.5423/36/1/3: Cultivated pasture: evaluation of legumes in association with *Eragrostis curvula* in the summer rain cropping area of the South-eastern Transvaal. 1973. N.F.G. Rethman

T.5423/36/1/4: Cultivated pasture: evaluation of perennial grasses under dryland conditions for incorporation in livestock production systems in the summer rain cropping area of South-eastern Transvaal. 1973. N.F.G. Rethman

T.5423/36/1/6: Cultivated pasture: the potential of *Digitaria eriantha* (Smutsii) and a mixture of *D. eriantha* and *Medicago sativa* for woolled sheep in the summer rain cropping area of Transvaal Region. 1984. C.C. de Witt

MANAGEMENT/BESTUUR

T.5423/41/1/1: Cultivated pasture: evaluation of *Eragrostis curvula* for intensive sheep production in the summer rain cropping area of the South-eastern Transvaal. 1972. N.F.G. Rethman

T.5423/41/1/2: Cultivated pasture: optimisation of grazing management of *C. varia* in the summer rain cropping area of Transvaal Region. 1985. D.L. Barnes

LUCERNE/LUSERN

CROP SCIENCE/GEWASKUNDE

H.5424/30/1/1: Lucerne: nursery evaluation of new lucerne cultivars in the summer rain cropping areas. 1981. R.H. Drewes

T.5424/30/1/1: Lucerne: cultivation of lucerne on different ecological units with different espacements and seeding rates in the summer rain cropping area. 1975. N.F.G. Rethman

ANNUAL FODDER CROPS/EENJARIGE VOERGEWASSE

CROP SCIENCE/GEWASKUNDE

H.5425/30/1/1: Annual fodder crops: nursery evaluation of annual winter fodder crops in the eastern summer rain cropping areas. 1977. R.H. Drewes

Eastern seaboard areas/Oostelike kusgebiede

CULTIVATED PASTURE/AANGEPLANTE WEIDING

NUTRITION/VOEDING

D.5433/05/1/1: Cultivated pasture: the phytomass potential of Rhodes grass on a Shorrocks series soil at Bathurst at various nitrogenous and phosphatic levels. 1981. C.J.G. le Roux

D.5433/05/1/2: Cultivated pasture: the phytomass potential of Coastcross II on a Shorrocks soil series at Bathurst on the eastern seaboard of the Eastern Cape at various nitrogen and phosphatic levels. 1983. C.J.G. le Roux

CROP SCIENCE/GEWASKUNDE

D.5433/30/1/1: Cultivated pasture: maintenance and management of the pasture nursery at Bathurst in the eastern seaboard areas of the Eastern Cape. 1981. T. Daines

D.5433/30/1/2: Cultivated pasture: seeding rate and weed control in the establishment of Rhodes grass in the eastern seaboard areas of the Eastern Cape. 1981

POTENTIAL STUDIES/POTENSIAALSTUDIES

D.5433/36/1/1: Cultivated pasture: potential of established pastures with regard to Dohne Merinos in the eastern seaboard areas of the Eastern Cape. 1976. F.O.C.W. Karberg

MANAGEMENT/BESTUUR

D.5433/41/1/1: Cultivated pasture: potential of three grasses in the eastern seaboard north-east of East London. 1981. A.J. Aucamp

D.5433/41/1/2: Cultivated pasture: potential of star grass in the eastern seaboard areas north-east of East London for beef production. 1977. A.J. Aucamp

D.5433/41/1/3: Cultivated pasture: potential of summer grasses in the Albax eastern seaboard area. 1977. T. Daines

D.5433/41/1/4: Cultivated pasture: potential of temperate grasses in the Albax eastern seaboard areas. 1982. T. Daines

D.5433/41/1/5: Cultivated pasture: growth and production of summer grasses in the eastern seaboard areas north-east of East London. 1977. L.O. Nel

D.5433/41/1/6: Cultivated pasture: growth and production of temperate grasses in the eastern seaboard areas north-east of East London. 1977. L.G. Howe

D.5433/41/1/7: Cultivated pasture: screening of legumes in the eastern seaboard areas north-east of East London. 1977. C.J.G. le Roux

D.5433/41/1/8: Cultivated pasture: screening of annual legumes in the Albany/Alexandria eastern seaboard areas. 1977. T. Daines

D.5433/41/1/9: Cultivated pasture: evaluation of the Rhodes grass for beef production in the eastern seaboard areas at Bathurst. 1977. T. Daines

D.5433/41/1/10: Cultivated pasture: evaluation of Coastcross II for beef production in the eastern seaboard areas of the Eastern Cape. 1983. T. Daines

D.5433/41/1/11: Cultivated pasture: the influence of pasture availability, structure and maturity of kikuyu on the grazing behaviour and production of dairy cows in the eastern seaboard areas of the Eastern Cape. 1983. T. Daines

VELD

D.5433/41/1/12: Cultivated pasture: screening of perennial legumes for the eastern seaboard of the Eastern Cape. 1984. T. Daines

W.5433/41/1/1: Cultivated pasture: investigation of planted pasture crops for the eastern seaboard area by cutting methods. 1973. J.M. van Heerden

High rainfall sourveld areas/Hoëreënsuurveldgebiede

VELD

PESTS/PLAE

N.5441/20/1/1: Veld: soil inhabiting insects damaging veld in the high rainfall sourveld areas of Natal Region. 1970. P.C. Joubert

CROP SCIENCE/GEWASKUNDE

T.5441/30/1/1: Veld: fertilisation of veld pastures in the north-eastern high rainfall sourveld. 1969. N.F.G. Rethman

T.5441/30/1/2: Veld: growth and development of *Diheteropogon amplectans* and *Eulalia villosa* in veld pastures of the high rainfall sourveld area of South-eastern Transvaal. 1973. N.F.G. Rethman

POTENTIAL STUDIES/POTENSIAALSTUDIES

T.5441/36/1/1: Veld: veld observation of selection patterns of grazing animals on veld pastures in the high rainfall sourveld of the South-eastern Transvaal. 1971. N.F.G. Rethman

T.5441/36/1/2: Veld: *Oesophageal fistula* sample investigation of plant species on veld pastures in the high rainfall sourveld of South-eastern Transvaal. 1971. N.F.G. Rethman

PERSUASION/OORREDING

N.5441/39/2/1: Control of American bramble (*Rubus cuneifolius*) in the natural grazing in bioclimate group 4 in the Howick and Richmond Extension Wards. 1981. R.M. Webster

MANAGEMENT/BESTUUR

D.5441/41/1/1: Veld: stocking density and species and area selection in the Dohne sourveld in the high rainfall sourveld areas. 1972. T. Daines

N.5441/41/1/1: Veld: veld burning and mowings in Bioclimate 4e of the high rainfll sourveld areas at Thabamhlope. 1946. B.D. Mappledoram

N.5441/41/1/2: Veld: regrowth rates of veld burnt at various times in spring in the high rainfall sourveld areas of Natal Region. 1981. P.C.V. du Toit

N.5441/41/1/3: Veld: beef steers grazing sandy high rainfall sourveld areas at six stocking rates at Dundee. 1981. P.C.V. du Toit

N.5441/41/1/4: Veld: evaluation of veld potential with beef cattle in the high rainfall sourveld areas of Natal Region. 1975. A.D. Lyle

N.5441/41/2/1: Veld: studies on bush and shrub encroachment in the Munden area of the high rainfall sourveld areas of Natal Region. 1979. K.G.T. Kamp

MODELLING/MODELLERING

N.5441/42/1/1: Veld: development and refining of a model for the prediction of beef production in the high rainfall sourveld areas of Natal. 1984. M.B. Hardy

RADICAL VELD IMPROVEMENT/RADIKALE VELDVERBETERING

MANAGEMENT/BESTUUR

D.5442/41/1/1: Radical veld improvement: methods to control nassella in the high rainfall sourveld areas of the Eastern Cape. 1978. A.J. Aucamp

CULTIVATED PASTURE/AANGEPLANTE WEIDING

NUTRITION/VOEDING

N.5443/05/1/1: Cultivated pasture: phosphate and lime nutrition of *Trifolium*/*Festuca* in cultivated pasture on dystrophic soils in Bioclimate 3 of the high rainfall sourveld areas. 1976. N. Miles

N.5443/05/1/2: Cultivated pasture: phosphate and lime nutrition of *Trifolium* pasture on dystrophic soils in Bioclimate 3 of the high rainfall sourveld areas of Natal Region. 1976. N. Miles

N.5443/05/1/3: Cultivated pasture: effect of various levels of N, P and K on the productivity of Coastcross 2 in Bioclimate 3 in the high rainfall sourveld areas. 1974. P.E. Bartholomew

N.5443/05/1/4: Cultivated pasture: phosphate and potash requirements of *Eragrostis curvula* on Leksand in Bioclimate 8 in the high rainfall sourveld areas. 1974. P.E. Bartholomew

N.5443/05/1/5: Cultivated pasture: N, P, K and lime for *Eragrostis curvula* in Bioclimate 6 of the high rainfall sourveld areas. 1974. P.E. Bartholomew

N.5443/05/1/6: Cultivated pasture: *Pennisetum clandestinum* response to N, P and lime on highly weathered soils of the high rainfall sourveld areas of Cedara. 1981. N. Miles

N.5443/05/1/7: Cultivated pasture: nutrition requirements of kikuyu - response to top-dressed nutrients in the high rainfall sourveld areas. 1981. N. Miles

N.5443/05/1/8: Cultivated pasture: response of kikuyu to nitrogen phosphorus and lime on a highly leached soil in the high rainfall sourveld areas. 1982. N. Miles

N.5443/05/1/9: Cultivated pasture: response of kikuyu to phosphorus, calcium, magnesium and potassium on a highly leached soil in the high rainfall sourveld areas of Natal. 1982. N. Miles

N.5443/05/1/10: Cultivated pasture: response of white clover to phosphorus, potassium and lime on a highly leached soil in the high rainfall sourveld areas of Natal Region. 1983. N. Miles

N.5443/05/1/11: Cultivated pasture: response of white clover to phosphorus, sulphur, molybdenum and lime on a highly leached soil in the high rainfall sourveld of Natal Region. 1983. N. Miles

N.5443/05/1/12: Cultivated pasture: response of Midmar Italian rye grass to N, P and K applications in the high rainfall sourveld areas of Natal. 1985. N. Miles

UPGRADING/VEREDELING

N.5443/07/1/1: Cultivated pasture: breeding with *Paspalum dilatatum* for the high rainfall sourveld areas at Cedara. 1959. J.M.L.C. Rhind

AANGEPLANTE WEIDING

N.5443/07/1/2: Cultivated pasture: breeding with *Dactylis glomerata* for the high rainfall sourveld areas at Cedara. 1959. J.M.L.C. Rhind

N.5443/07/1/3: Cultivated pasture: breeding with *Lolium multiflorum* for the high rainfall sourveld areas at Cedara. 1959. J.M.L.C. Rhind

N.5443/07/1/4: Cultivated pasture: breeding with *Eragrostis curvula* for the high rainfall sourveld areas at Cedara. 1970. J.M.L.C. Rhind

N.5443/07/1/5: Cultivated pasture: breeding with *Acroceras macrum* for the high rainfall sourveld areas. 1970. J.M.L.C. Rhind

N.5443/07/1/6: Cultivated pasture: breeding with *Digitaria eriantha* for the high rainfall sourveld areas at Kokstad. 1974. A. Smith

N.5443/07/1/7: Cultivated pasture: breeding with *Trifolium* for the high rainfall sourveld areas at Cedara. 1977. A. Smith

N.5443/07/1/8: Cultivated pasture: *Festuca arundinacea* breeding. 1978. J.M.L.C. Rhind

N.5443/07/1/9: Cultivated pasture: breeding with *Lolium perenne*. 1978. A. Smith

N.5443/07/1/10: Cultivated pasture: breeding and selection of *Lolium multiflorum* cultivars for improved autumn, winter and summer growth in the high rainfall sourveld areas. 1982. G.F. Watt-Pringle

N.5443/07/2/1: Cultivated pasture: tissue and anther culture in white clover in the high rainfall sourveld areas at Cedara. 1981. G.F. Smith

N.5443/07/3/1: Cultivated pasture: breeder seed production and monitoring of commercial seed of Cedara-bred cultivars. 1983. A.R.J. Morrison

NITROGEN FIXATION/STIKSTOFBINDING

N.5443/09/1/1: Cultivated pasture: selection of *Rhizobium* strains for *Trifolium* in the high rainfall sourveld areas. 1967. A. Smith

PATHOLOGY/PATOLOGIE

N.5443/19/1/1: Cultivated pasture: pathological surveys of *Pennisetum clandestinum, E. curvula* and *Lolium* spp. in the Natal midlands area of the high rainfall sourveld areas. 1983. A.S. Hall

CHEMICAL CONTROL/CHEMIESE BEHEER

D.5443/21/1/1: Cultivated pasture: screening pasture plants for tolerance tetrapion in the high rainfall sourveld areas. 1983. C.J.G. le Roux

CROP SCIENCE/GEWASKUNDE

D.5443/30/1/1: Cultivated pasture: maintenance and management of the pasture nursery at Dohne in the high rainfall sourveld areas. 1975. C.J.G. le Roux

D.5443/30/1/2: Cultivated pasture: evaluation of *Dactylis glommerata* in the high rainfall sourveld areas of the Eastern Cape. 1976. L.O. Nel

N.5443/30/1/1: Cultivated pasture: plant materials centre in Bioclimate 6 of the high rainfall sourveld areas. 1972. B.D. Mappledoram

N.5443/30/1/2: Cultivated pasture: plant material sub-centre in Bioclimate 4e of the high rainfall sourveld areas at Thabamhlope. 1972. B.D. Mappledoram

N.5443/30/3/1: Cultivated pasture: legumes suitable for kikuyu pasture in Bioclimate 3 of the high rainfall sourveld areas. 1978. C.I. Macdonald

CULTIVATED PASTURE

N.5443/30/3/2: Cultivated pasture: management of red clover in a kikuyu pasture in the high rainfall sourveld areas. 1981. C.I. Macdonald

N.5443/30/4/1: Cultivated pasture: *Lolium multiflorum* seed production in the high rainfall sourveld areas. 1981. D.C.W. Goodenough

N.5443/30/4/2: Cultivated pasture: *Trifolium repens* seed production in the high rainfall sourveld areas. 1981. A. Smith

N.5443/30/5/1: Cultivated pasture: *Dactylis glomerata* cultivar trials in Bioclimates 3, 4 and 6 of the high rainfall sourveld areas. 1977. B.D. Mappledoram

N.5443/30/5/2: Cultivated pasture: *Festuca arundinacea* cultivar trials in Bioclimates 3, 4 and 6 of the high rainfall sourveld areas. 1978. B.D. Mappledoram

N.5443/30/5/3: Cultivated pasture: *Eragrostis curvula* cultivar trial in Bioclimate 4e on Clovelly soil in the high rainfall sourveld areas. 1968. B.D. Mappledoram

N.5443/30/5/4: Cultivated pasture: *Cynodon* cultivar trial in Bioclimate 6 in the high rainfall sourveld areas. 1972. B.D. Mappledoram

N.5443/30/5/7: Cultivated pasture: comparison of various tropical grasses and legumes on an Arrochar soil in Bioclimate 4f in the high rainfall sourveld areas. 1973. N.N. Gray

N.5443/30/5/8: Cultivated pasture: *Cynodon* cultivar trial with grazing (Phase 2) in Bioclimate 8 of the high rainfall sourveld areas. 1977. B.D. Mappledoram

N.5443/30/5/9: Cultivated pasture: *Cynodon* cultivar trial with grazing (Phase 2) on an Avalon soil in Bioclimate 8 of the high rainfall sourveld areas. 1977. B.D. Mappledoram

N.5443/30/5/10: Cultivated pasture: *Cynodon* cultivar trial with grazing (Phase 2) on Uitvlugt soil in Bioclimate 8 of the high rainfall sourveld areas. 1977. B.D. Mappledoram

N.5443/30/5/11: Cultivated pasture: *Trifolium pratense* cultivar trial in Bioclimate 4e of the high rainfall sourveld areas. 1978. B.D. Mappledoram

N.5443/30/5/12: Cultivated pasture: classification, processing and assessment of available pasture data in the high rainfall sourveld areas of Natal. 1976. J.K. Arnott

N.5443/30/5/13: Cultivated pasture: foggage value of pastures in Bioclimate 3 of the high rainfall sourveld areas. 1978. P.C.V. du Toit

N.5443/30/5/14: Cultivated pasture: foggage value of pastures in Bioclimate 4f of the high rainfall sourveld areas. 1981. N.N. Gray

N.5443/30/5/15: Cultivated pasture: temperate pastures under irrigation in Bioclimate 4e of the high rainfall sourveld areas. 1980. T.M. du Plessis

N.5443/30/5/16: Cultivated pasture: effect of the site on the production of pasture species in Bioclimate 3 of the high rainfall sourveld. 1981. G.F. Watt-Pringle

N.5443/30/6/1: Cultivated pasture: making kikuyu grass silage in the high rainfall sourveld areas. 1979

N.5443/30/6/2: Cultivated pasture: making Italian rye grass silage in the high rainfall sourveld areas. 1983

N.5443/30/7/1: Cultivated pasture: growth and development of kikuyu in the high rainfall sourveld areas. 1981. P.C.V. du Toit

N.5443/30/7/2: Cultivated pasture: evaluation of cold tolerance of kikuyu in the high rainfall sourveld areas. 1977

MANAGEMENT/BESTUUR

D.5443/41/1/1: Cultivated pasture: evaluation of pasture species for veld reinforcement in the Dohne high rainfall sourveld areas. 1979. C.J.G. le Roux

EENJARIGE VOERGEWASSE

D.5443/41/1/2: Cultivated pasture: growth patterns of summer grasses in the Dohne high rainfall sourveld areas of the Eastern Cape. 1979. C.J.G. le Roux

D.5443/41/1/3: Cultivated pasture: potential of temperate grasses in the Dohne high rainfall sourveld areas of the Eastern Cape. 1979. C.J.G. le Roux

D.5443/41/1/4: Cultivated pasture: screening of annual temperate legumes in the Dohne high rainfall sourveld areas. 1979. C.J.G. le Roux

D.5443/41/2/1: Cultivated pasture: to replace nassella in the high rainfall sourveld areas of the Eastern Cape. 1978. C.J.G. le Roux

N.5443/41/1/1: Strip replacement of Ngogoni veld in Bioclimate 3. 1978. C.I. Macdonald

N.5443/41/1/2: Cultivated pasture: animal production from Coastcross 2 under different management systems in Bioclimate 3 of the high rainfall sourveld areas. 1974. J.K. Arnott

N.5443/41/1/4: Cultivated pasture: *Dactylis glomerata* with and without legumes at two stocking rates in Bioclimate 3 of the high rainfall sourveld areas. 1979. C.I. Macdonald

N.5443/41/1/5: Cultivated pasture: irrigated grass clover pasture grazed by sheep in Bioclimate 4e of the high rainfall sourveld areas. 1981. T.M. du Plessis

N.5443/41/1/6: Cultivated pasture: steers on various pastures in Bioclimate 4e of the high rainfall sourveld areas. 1972. B.D. Mappledoram

N.5443/41/1/7: Cultivated pasture: cows and calves on artificial pastures in Bioclimate 4e of the high rainfall sourveld areas. 1973. B.D. Mappledoram

N.5443/41/1/8: Cultivated pasture: steers on star grass at three stocking rates in Bioclimate 6 of the high rainfall sourveld areas. 1972. B.D. Mappledoram

N.5443/41/1/9: Cultivated pasture: effect of stocking rate on the performance of weaners on irrigated *Lolium multiflorum* in Bioclimate 3 of the high rainfall sourveld areas. 1979. P.E. Bartholomew

N.5443/41/1/10: Cultivated pasture: effect of stocking rate and nitrogen fertiliser on the performance of steers on *Digitaria eriantha* and *Eragrostis curvula* legume in Bioclimate 4f of the high rainfall sourveld areas. 1981. U.P. Kreuter

N.5443/41/1/11: Cultivated pasture: effect of stocking rate and nitrogen fertiliser on the performance of wethers on various pastures on upland and bottomland in Bioclimate 4f of the high rainfall sourveld areas. 1981. U.P. Kreuter

N.5443/41/1/12: Cultivated pasture: fertilisation of old lands under grazing in Bioclimate 8 of the high rainfall sourveld areas at Dundee. 1974. P.C.V. du Toit

LUCERNE/LUSERN

SOIL SCIENCE/GRONDKUNDE

D.5444/32/1/1: Lucerne: the effect of acid soil conditions on above- and below-ground growth and development of lucerne with special reference to seeding establishment in the high rainfall sourveld areas of the Eastern Cape Region. 1984. G.R. Barnes

ANNUAL FODDER CROPS/EENJARIGE VOERGEWASSE

CROP SCIENCE/GEWASKUNDE

N.5445/30/1/1: Annual fodder crops: collation of data from legumes in the high rainfall sourveld areas. 1977. F.R.T. Hyam

Karoo and arid areas/Karoo en ariede gebiede

VELD

PHYSIOLOGY/FISIOLOGIE

V.5451/03/1/1: Veld: a study of the carbohydrate status of the different plant organs of *Rhigozum trichotomum* over the season in a natural habitat of the Karakul Research Station in the Karoo and arid areas at Upington. 1984. A. Moore

CHEMICAL CONTROL/CHEMIESE BEHEER

K.5451/21/1/1: Chemical control of *Prosopis* species in the veld of the North-western Karoo and arid areas. 1978. M. Vorster

ECOLOGY/EKOLOGIE

V.5451/27/1/1: Veld: a study of the influence of *Rhigozum trichotomum* on other plants in a natural habitat on the Karakul Research Station in the Karoo and arid areas at Upington. 1983. A. Moore

V.5451/27/1/2: Veld: a study of the phenological development and vegetative reproduction of *Rhigozum trichotomum* in a natural habitat on the Karakul Research Station at Upington. 1984. A. Moore

POTENTIAL STUDIES/POTENSIAALSTUDIES

K.5451/36/1/1: Veld: phytomass determination and production of 11 veld types in the Karoo and arid areas. 1978. P. Botha

K.5451/36/1/2: Veld: phytomass determination of vegetation in different phenophases in the Meentspruit farming area of the Karoo and arid areas. 1978. P. Botha

K.5451/36/2/1: Veld: determination of relative grazing value indices for the different plant ecological groups in the eastern mixed veld of the Karoo and arid areas. 1983. M. Vorster

K.5451/36/2/2: Veld: determination of relative grazing value indices for the different plant ecological groups in the North-west Karoo and arid areas. 1983. M. Vorster

K.5451/36/2/3: Veld: determination of relative grazing value indices for the different plant ecological groups in the mountain area of the Karoo and arid areas. 1983. M. Voster

K.5451/36/2/4: Veld: determination of relative grazing value indices for the different plant ecological groups in the Karoo and arid areas: Great Karoo. 1983. M. Vorster

V.5451/36/1/1: Veld: monitoring of the influence of game on veld in the Karoo and arid areas of the Spitskop Nature Reserve at Upington. 1983. J.H. Fourie

MANAGEMENT/BESTUUR

K.5451/41/1/1: Veld: principles of management of apron veld in the eastern mixed Karoo and arid areas. 1934. P.W. Roux

K.5451/41/1/2: Veld: principles of management of flat veld in the eastern mixed Karoo and arid areas. 1934. P.W. Roux

K.5451/41/1/3: Veld: principles of management of sandstone and dolerite hilly veld in the eastern mixed Karoo and arid areas. 1943. P.W. Roux

K.5451/41/1/5: Veld: determination of animal ratios in the Noorsveld based on diet selection by Angora goats, Boer goats, Dorper and Merino sheep. 1984. P. Botha

K.5451/41/1/6: Veld: determination of animal ratio on a mixed dwarf shrub veld in the Karoo and arid areas based on diet selection by the Afrino, Dorper and Merino sheep and Angora goats. 1984. P. Botha

TECHNOLOGY/TEGNOLOGIE

K.5451/52/1/1: Veld: development of a photographic technique for the evaluation of change of the Karoo and arid areas. 1974. P.W. Roux

CULTIVATED PASTURE/AANGEPLANTE WEIDING

MANAGEMENT/BESTUUR

W.5453/41/1/1: Cultivated pasture: investigation of new planted pasture crops in the Karoo and arid areas of the Winter Rainfall Region. 1973. J.D. Langenhoven

LUCERNE/LUSERN

UPGRADING/VEREDELING

K.5454/07/1/1: Evaluation of lucerne introductions at Grootfontein in the Karoo and arid areas. 1958. G.C. de Kock

K.5454/07/1/2: Selection of lucerne for resistance to salinity and moisture stress in the Karoo and arid areas. 1961. G.C. de Kock

K.5454/07/1/3: Lucerne: selection of lucerne for acid tolerance (aluminium and pH) in the Karoo and arid areas. 1960. G.C. de Kock

K.5454/07/1/4: Lucerne: selection of lucerne for insect tolerance in the Karoo and arid areas. 1960. G.C. de Kock

K.5454/07/1/5: Lucerne: selection of lucerne for resistance to root disease in the Karoo and arid areas. 1960. G.C. de Kock

K.5454/07/1/6: Lucerne: selection of lucerne for resistance to leaf disease in the Karoo and arid areas. 1960. G.C. de Kock

K.5454/07/1/7: Lucerne: selection of creeper lucerne types for pasture in the Karoo and arid areas. 1960. G.C. de Kock

K.5454/07/1/8: Evaluation of selected South African lucerne types at Grootfontein in the Karoo and arid areas. 1958. G.C. de Kock

CROP SCIENCE/GEWASKUNDE

V.5454/30/1/1: Lucerne: an investigation of the adaptability of lucerne cultivars which are resistant to the blue-green aphid and pea aphid under irrigation at Upington. 1982. J.P. van Niekerk

NORM STUDIES/NORMSTUDIES

K.5454/50/1/1: Development of standards of grading of lucerne hay in the Karoo and arid areas. 1982. G.C. de Kock

K.5454/50/1/2: Lucerne: factors which effect quality and grading of lucerne in the Karoo and arid areas. 1982. G.C. de Kock

DROUGHT FODDER CROPS/DROOGTEVOERGEWASSE

UPGRADING/VEREDELING

K.5456/07/1/1: Drought fodder crops: improvement of *Atriplex nummularia* by breeding and selection in the Karoo and arid areas. 1962. G.C. de Kock

K.5456/07/2/1: Drought fodder crops: selection and breeding of spineless cactus in the Karoo and arid areas. 1964. G.C. de Kock

K.5456/07/2/2: Drought fodder crops: selection for absence of spines in cactus in the Karoo and arid areas. 1966. G.C. de Kock

K.5456/07/3/1: Introduction of various forage and drought resistant fodder crops and their evaluation at Grootfontein in the Karoo and arid areas. 1964. G.C. de Kock

Central grassveld areas/Sentrale grasveldgebiede

VELD

TAXONOMY/TAKSONOMIE

D.5461/01/1/1: Veld: reference herbaria at Dohne in the central grassveld areas of the Eastern Cape Region. 1976

PHYSIOLOGY/FISIOLOGIE

D.5461/03/1/1: Veld: carbohydrate accumulation and depletion patterns in key grass species in the central grassveld areas of the Eastern Cape. 1980. J.E. Danckwerts

D.5461/03/1/2: Veld: crop growth rate of key grass species in the central grassveld areas of the Eastern Cape. 1982. J.E. Danckwerts

D.5461/03/1/3: Veld: effect of seasonality and plant age on the net assimilation rate of key grass species in the central grassveld areas of the Eastern Cape. 1982. J.E. Danckwerts

D.5461/03/1/4: Veld: annual carbohydrate use and replenishment cycle of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5461/03/1/5: Veld: carbohydrate replenishment in *Acacia karroo* following defoliation in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5461/03/1/6: Veld: the effect of defoliation on the rate of photosynthesis of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

D.5461/03/1/7: Veld: the effect of defoliation on the root/shoot balance of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

ECOLOGY/EKOLOGIE

D.5461/27/1/1: Veld: the effect of *Acacia karroo* on basal cover, species composition and production of the herbaceous community in the central grassveld areas of the Eastern Cape. 1982. G.C. Stuart-Hill

D.5461/27/1/2: Veld: mortality and heterotrophic consumption of *Acacia karroo* leaves in the central grassveld of the Eastern Cape. 1982. W.R. Teague

CROP SCIENCE/GEWASKUNDE

D.5461/30/1/1: Veld: growth and development of key grass species in the central grassveld areas of the Eastern Cape. 1980. J.E. Danckwerts

D.5461/30/1/2: Veld: root growth and development of key grass species in the central grassveld areas of the Eastern Cape. 1980. J.E. Danckwerts

D.5461/30/1/3: Veld: root growth and development of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. G.C. Stuart-Hill

D.5461/30/1/4: Veld: growth patterns of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5461/30/1/5: Veld: the effect of different intensities of defoliation at different phenological stages on the aerial growth of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5461/30/1/6: Veld: the effect of different frequencies and intensities of defoliation under a wet and dry moisture regime on the above-ground parts of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1983. W.R. Teague

D.5461/30/1/7: Veld: the effect of frequency of defoliation on the key grass species in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

WATER REQUIREMENTS/WATERBEHOEFTES

D.5461/31/1/1: Veld: water requirements and utilisation of *Acacia karroo* and key grass species during different times of the year in the grassveld areas in the Eastern Cape in relation to their production. 1982. G.C. Stuart-Hill

D.5461/31/1/2: Water stress and the growth of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1983. W.R. Teague

D.5461/31/1/3: Veld: the effect of water stress on the rate of photosynthesis and root/shoot balance following defoliation of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

D.5461/31/1/4: Veld: water use by *Acacia karroo* as influenced by defoliation in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

SOIL SCIENCE/GRONDKUNDE

D.5461/32/1/1: Veld: a study of soil factors which affect plant composition in the central grassveld areas of the Eastern Cape Region. 1982. G.C. Stuart-Hill

POTENTIAL STUDIES/POTENSIAALSTUDIES

D.5461/36/1/1: Veld: the rate and depth of water infiltration following rain on the Adelaide Experiment Farm in the central grassveld areas of the Eastern Cape Region. 1982. G.C. Stuart-Hill

D.5461/36/1/4: Veld: species preference and production of grasses at the Adelaide Experiment Site in the central grassveld areas of the Eastern Cape Region. 1982. A.J. Aucamp

D.5461/36/1/5: Veld: herbage yield and growth curves of various swards dominated by key grass species in the central grassveld areas of the Eastern Cape Region. 1980. J.E. Danckwerts

D.5461/36/1/6: Veld: the influence of seasonal defoliation of either the *Acacia karroo*, the herbaceous component or both on browse and grass production in the central grassveld areas of the Eastern Cape Region. 1982. G.C. Stuart-Hill

D.5461/36/1/7: Veld: the effect of defoliation on key grass species during a period of water stress on subsequent regrowth and production in the central grassveld areas of the Eastern Cape. 1982. G.C. Stuart-Hill

V.5461/36/1/1: Veld: an investigation of the production potential of Boer goats on veld in the central grassveld area invaded by *Acacia karroo* at Glen. 1983. L. Viljoen

MANAGEMENT/BESTUUR

D.5461/41/1/4: Pattern and consumption rates of *Acacia karroo* communities by goats as a function of stocking pressure in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

V.5461/41/1/1: Veld: influence of various degrees of defoliation by cattle on veld and animal production at Glen. 1977. J.P. van Niekerk

MODELLING/MODELLERING

D.5461/42/1/1: Veld: a model simulating the effect of probable uses of the natural vegetation in the thornbush-grass communities in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

CULTIVATED PASTURE/AANGEPLANTE WEIDING

NUTRITION/VOEDING

V.5463/05/1/1: Cultivated pasture: determination of nutrient requirements of *Sporobolus fimbriatus* by means of pot experiments at Glen in the central grassveld areas. 1981. L. Viljoen

CROP SCIENCE/GEWASKUNDE

D.5463/30/1/1: Cultivated pasture: maintenance and management of the pasture nursery at Clifford, Barkly East, in the central grassveld of the Eastern Cape. 1983. C.J.G. le Roux

V.5463/30/1/1: Cultivated pasture: phase-1 evaluation of pasture plants at Glen in the central grassveld areas. 1974. L. Viljoen

POTENTIAL STUDIES/POTENSIAALSTUDIES

V.5463/36/1/1: Cultivated pasture: the evaluation of *Cenchrus ciliaris* pasture for beef production in the central grassveld area at Glen. 1978. J.P. van Niekerk

V.5463/36/1/2: Cultivated pasture: an evaluation of *Sporobolus fimbriatus* as a pasture in respect of production potential and quality in the central grassveld areas at Glen. 1983. J.P. van Niekerk

V.5463/36/1/3: Cultivated pasture: an investigation on the finishing of cattle on *Cenchrus ciliaris* pastures in the central grassveld areas at Glen. 1984. J.P. van Niekerk

LUCERNE/LUSERN

CROP SCIENCE/GEWASKUNDE

V.5464/30/1/1: Lucerne: to determine the optimal row-spacing and seeding rates for lucerne under dryland conditions in the central grassveld areas at Glen. 1983. H.J. Fouché

V.5464/30/1/2: Lucerne: the influence of the frequency of interrow cultivation on the production of dryland lucerne under grazing in the central grassveld area at Glen. 1983. H.J. Fouché

V.5464/30/1/3: Lucerne: an investigation of the adaptability of lucerne cultivars resistant to the blue-green aphid and pea aphid under dryland conditions in the central grassveld area of the Free State Region. 1984. J.P. van Niekerk

Winter rain cropping areas/Winterreënsaaigebiede

VELD

ENTOMOLOGY/ENTOMOLOGIE

W.5471/14/1/1: Veld: taxonomy and ecology of the *Collembola* in veld and other situations in the winter rain cropping area. 1966. M.C. Walters

MANAGEMENT/BESTUUR

W.5471/41/1/1: Veld: the effect of grazing by small stock and cattle on the cover and composition of Strandveld in the winter rain cropping area. 1983. J.E. Wicht

W.5471/41/1/2: Veld: the effect of seasonal defoliation on the reserves and dry matter production of veld, Karoo bushes and grasses in the winter rain cropping area. 1977. J.E. Wicht

W.5471/41/1/3: Veld: the evaluation and seed multiplication of natural pasture species at Worcester veld reserve in the winter rain cropping area. 1977. J.E. Wicht

W.5471/41/1/4: Veld: nursery - Nortier Experiment Station in the winter rain cropping area. 1979. J.E. Wicht

RADICAL VELD IMPROVEMENT/RADIKALE VELDVERBETERING

MANAGEMENT/BESTUUR

W.5472/41/1/1: Radical veld improvement: the evaluation of *Chrysanthemoides, Medicago,* and *Atriplex* species for radical veld improvement in the Sandveld of the winter rain cropping area. 1978. J.E. Wicht

CULTIVATED PASTURE/AANGEPLANTE WEIDING

NUTRITION/VOEDING

W.5473/05/1/1: Cultivated pasture: determination of the phosphorus requirements of annual Mediterranean pasture legumes in the Ruens area of the winter rain cropping area. 1979. J.D. Langenhoven

PESTS/PLAE

W.5473/20/1/1: Cultivated pasture: control of the lucerne springtail, *Sminthurus viridis* (L) and the black sandmite, *Halotydeus destructor* (Tucker) in the winter rain cropping area. 1960. J. Lombard

CHEMICAL CONTROL/CHEMIESE BEHEER

W.5473/21/1/1: Cultivated pasture: chemical weed control in cultivated pastures under dryland cultivation in the Swartland and Ruens of the winter rain cropping area. 1979. D. le Roux

MANAGEMENT/BESTUUR

W.5473/41/1/1: Cultivated pasture: carrying capacity on planted pasture and small grain rotation in the Ruens area of the winter rain cropping area. 1972. J.D. Langenhoven

CULTIVATED PASTURE

W.5473/41/1/2: Cultivated pasture: determination of carrying capacity of dryland planted with grass/legume pastures at Tygerhoek in the Ruens of the winter rain cropping area. 1979. J.M. van Heerden

W.5473/41/1/3: Cultivated pasture: comparison of capacity of dryland pasture mixtures under different soil climate conditions in the Ruens of the winter rain cropping area. 1982. J.M. van Heerden

W.5473/41/1/4: Cultivated pasture: determination of optimum sowing time and sowing density for medics in the Swartland of the winter rain cropping area. 1981. J.D. Langenhoven

W.5473/41/1/5: Cultivated pasture: investigation of new dryland pasture crops in the Swartland and Boland of the winter rain cropping area. 1973. J.D. Langenhoven

W.5473/41/1/6: Cultivated pasture: investigation of new dryland planted with pasture crops at Elsenburg and in the Ruens of the winter rain cropping area by means of cutting methods. 1973. J.M. van Heerden

ANNUAL FODDER CROPS/EENJARIGE VOERGEWASSE

MANAGEMENT/BESTUUR

W.5475/41/1/1: Annual fodder crops: small plot evaluation of annual fodder crops as an alternative for bitter lupin in the winter rain cropping area. 1979. J.D. Langenhoven

Irrigation areas/Besproeiingsgebiede

CULTIVATED PASTURE/AANGEPLANTE WEIDING

MANAGEMENT/BESTUUR

W.5483/41/1/1: Cultivated pasture: evaluation of kikuyu as a pasture crop in the irrigation area of Stellenbosch. 1982. J.D. Langenhoven

W.5483/41/1/2: Cultivated pasture: the evaluation of pasture legumes and grasses in the irrigation areas in the Winter Rainfall Region. 1979. J.M. van Heerden

W.5483/41/1/3: Cultivated pasture: carrying capacity of cultivated grass/legume pastures using different grazing methods in irrigation areas. 1979. J.M. van Heerden

W.5483/41/1/4: Cultivated pasture: the evaluation of grass/legume pastures under irrigation and dryland conditions and different grazing practices in the irrigation areas of the Winter Rainfall Region at George. 1983. J.M. van Heerden

W.5483/41/1/5: Cultivated pasture: investigation of new dryland pasture crops in the Swartland and Boland of the winter rain cropping area. 1973. J.D. Langenhoven

LUCERNE/LUSERN

NUTRITION/VOEDING

K.5484/05/1/1: Optimal fertiliser practices of irrigated lucerne in the Fish River irrigation area of the Karoo Region. 1982. G.C. de Kock

WATER REQUIREMENTS/WATERBEHOEFTES

K.5484/31/1/1: Irrigation requirements for the production of lucerne (hay and pasture) in the Fish River irrigation area of the Karoo Region. 1982. G.C. de Kock

PEULPLANTNAVORSING

SITUATION ANALYSIS/SITUASIEBEPALING

W.5484/35/1/1: A situation analysis with regard to factors influencing the producing and utilisation practices of lucerne in the irrigation area of Oudtshoorn extension ward. 1981. B.F.A. Visser

ANNUAL FODDER CROPS/EENJARIGE VOERGEWASSE

MANAGEMENT/BESTUUR

K.5485/41/1/1: Annual fodder crops: green forage production of small grain cultivars under irrigation in the irrigation areas of the Karoo Region. 1964. G.C. de Kock

K.5485/41/2/1: Annual fodder crops: forage production of different maize cultivars at Cradock in the irrigation areas of the Karoo Region. 1979. G.C. de Kock

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Supporting pasture research/Ondersteunende weidingsnavorsing

LEGUME RESEARCH/PEULPLANTNAVORSING

CROP SCIENCE/GEWASKUNDE

T.5491/30/1/1: Legume research: determination of inoculation requirements of pasture and fodder legumes in the summer rain cropping areas of Transvaal Region. 1977. V.D. Wassermann

T.5491/30/1/2: Legume research: determination of daylength and temperature requirements for normal flowering in specific pasture and fodder legumes in Transvaal Region. 1977. V.D. Wassermann

T.5491/30/1/3: Legume research: screening of pasture legumes for soil acidity tolerance in the Transvaal Region. 1977. V.D. Wassermann

T.5491/30/1/4: Legume research: a study of the effects of N fertiliser on the productivity of the white clover grass pasture in the Transvaal Region. 1981. V.D. Wassermann

T.5491/30/1/5: Legume research: a system in which maize is relay intercropped with annual temperate pasture legumes, with a view to improve winter grazing in the high rainfall sourveld areas. 1983. V.D. Wassermann

T.5491/30/1/6: Legume research: a study of the interrelation between, respectively, *Trifolium vesticulosum, Trifolium subterraneum* and *Lolium multiflorum* cv. Midmar in mixtures in the high rainfall sourveld areas. 1983. Marike van den Berg

T.5491/30/1/7: Legume research: the effect of babala (*Pennisetum americanum*) as support crop, nitrogenous fertiliser and seeding rate on the growth and production of dolichos bean (*Lablab purpureus*). 1983. A.J. Kruger

T.5491/30/2/1: Legume research: nursery trials with pasture and fodder legumes in Transvaal Region. 1978. V.D. Wassermann

T.5491/30/2/2: Legume research: yield studies of pasture and fodder legumes at Rietondale. 1978. A.J. Kruger

T.5491/30/2/3: Legume research: yield trials with temperate legumes in Transvaal Region. 1978. V.D. Wassermann

T.5491/30/2/4: A study of the effects of N fertiliser on the productivity of white clover grass pasture in the Transvaal Region. 1981. V.D. Wassermann

LEGUME RESEARCH

T.5491/30/3/3: Legume research: yield trials with temperate legumes in Transvaal Region. 1978. V.D. Wassermann

V.5491/30/1/1: Legume research: a study of five of the *Medicago* species in the central grassveld areas at Glen. 1980. L. Viljoen

PLANT ANALYSIS/PLANTANALISE

BIOTESTING/BIOTOETSING

N.5492/24/1/1: Plant analysis: correlations between animal production and *in vitro* digestion of plant material in the high rainfall sourveld areas. 1978. J.P. Marais

N.5492/24/1/2: Plant analysis: effect of nitrogen containing fractions of kikuyu on animal production in the high rainfall sourveld areas. 1978. J.P. Marais

RESOURCE UTILISATION RESEARCH (FARMING SYSTEMS) HULPBRONBENUTTINGSNAVORSING (BOERDERYSTELSELS)

Bushveld areas/Bosveldgebiede

STOCK FARMING/VEEBOERDERY

POTENTIAL STUDIES/POTENSIAALSTUDIES

D.5511/36/1/1: Stock farming: development of a viable stock farming for the valley bushveld areas in a good condition in the Eastern Cape Region. 1983. A.J. Aucamp

D.5511/36/1/2: Stock farming: development of a viable stock farming system for valley bushveld areas in a poor condition in the Eastern Cape Region. 1983. A.J. Aucamp

Summer rain cropping areas/Somerreënsaaigebiede

STOCK FARMING/VEEBOERDERY

MANAGEMENT/BESTUUR

H.5521/41/1/1: Stock farming: the influence of different feeding strategies on the economic and biological efficiency of beef cattle in the summer rain cropping areas. 1982. R.H. Drewes

High rainfall sourveld areas/Hoëreënsuurveldgebiede

STOCK FARMING/VEEBOERDERY

MANAGEMENT/BESTUUR

D.5541/41/1/1: Stock farming: the development of an adapted stock farming system of the Eastern Cape. 1983. H.H. Barnard

STRUKTUURSTUDIES

Central grassveld areas/Sentrale grasveldgebiede

CROP FARMING/SAAIBOERDERY

CROP SCIENCE/GEWASKUNDE

V.5562/30/1/1: Crop farming: evaluation of crop succession systems in which wheat and maize are grown under dryland conditions at Glen: central grassland areas. 1982. C. Engelbrecht

Winter rain cropping areas/Winterreënsaaigebiede

MIXED FARMING/GEMENGDE BOERDERY

MANAGEMENT/BESTUUR

W.5573/41/1/1: Mixed farming in the Swartland of the winter rain cropping area for optimum utilisation. 1973. J.D. Langenhoven

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AGRICULTURAL PRODUCTION ECONOMICS RESEARCH
LANDBOUPRODUKSIE-EKONOMIENAVORSING

Macro resource economics/Makrohulpbronekonomie

PRODUCTION FACTOR STUDIES/PRODUKSIEFAKTORSTUDIES

PRODUCTION ECONOMY/PRODUKSIE-EKONOMIE

PE.5611/48/1/1: Production factor studies: the determination of a remuneration for the management function in agricultural concerns. 1980. J.S.G. Joubert

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PE.5611/48/2/1: Production factor studies: the determination of the value of agriculture land in the RSA. 1976. A.H. Poray

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STRUCTURAL STUDIES/STRUKTUURSTUDIES

PRODUCTION ECONOMY/PRODUKSIE-EKONOMIE

PE.5612/48/3/1: Structural studies: determination of the extent nature and efficiency level of part-time farming in the RSA. 1980. J. Hough

*Facet terminated/Faset gestaak

STRUCTURAL STUDIES

PE.5612/48/3/2: Structural studies: an evaluation of the efficiency of part-time farmers in the North-western Transvaal bushveld. 1979. P.F. du Plessis

Farm business management/Plaasbedryfsleer

BUSINESS RESULTS/BEDRYFSRESULTATE

PRODUCTION ECONOMY/PRODUKSIE-EKONOMIE

PE.5621/48/1/1: Business results and the production cost of maize, sunflower and other branches of farming in the Eastern Transvaal summer rain cropping area. 1947. D.C. du Toit

PE.5621/48/1/2: Business results and the production cost of maize, sunflower and other branches of farming in the Western Transvaal summer rain cropping areas. 1947. D.J. Mulder

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PE.5621/48/3/1: Business results and the production cost of wheat and other branches of farming in the Swartland of the winter rain cropping area. 1947. D.C. du Toit

PE.5621/48/4/1: The summary and grouping of farm business results. 1980. D.C. du Toit

MANAGEMENT TECHNIQUES/BESTUURSTEGNIEKE

PRODUCTION ECONOMY/PRODUKSIE-EKONOMIE

PE.5622/48/1/1: Management techniques: the development of an elementary book keeping book for farmers. 1982. J.W. du Preez

PE.5622/48/1/2: Management techniques: the development transact plan 2 of the Agrirep system. 1982. A.D.E.K. Marais

PE.5622/48/1/3: Management techniques: research in respect of the drawing up and computerisation of income and cost budgets (Combud). 1981. W.F. Lubbe

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PE.5622/48/2/1: Management techniques: farm management studies with mail-in records as data source in the Winter Rainfall Region. 1961. J.W. du Preez

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BEDRYFSVERHOUDINGS

PE.5622/48/4/1: Management techniques: farm management studies with mail-in records as data source in the Karoo Region. 1964. D.S. Vorster

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PE.5622/48/6/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Winter Rainfall Region. 1973. J.W. du Preez

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PE.5622/48/7/3: Management techniques: preparation and updating of machinery cost standards. 1980. E.N.C. Whitehead

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ENTERPRISE RELATIONSHIPS/BEDRYFSVERHOUDINGS

PRODUCTION ECONOMY/PRODUKSIE-EKONOMIE

PE.5623/48/1/1: Enterprise relationship: research in respect of alternative farming systems in the Swartland in the winter rain cropping area. 1981

PE.5623/48/1/2: Enterprise relationship: economical research in respect of the control of false codling moth on citrus in the winter rain cropping area. 1981

ENTERPRISE RELATIONSHIPS

PE.5623/48/1/3: Enterprise relationship: research in respect of the difficulties in labour utilisation in Oriental tobacco production of the Western Cape in the winter rain cropping areas. 1981

PE.5623/48/2/2: Enterprise relationship: the introduction of long-term pasture crops in sheep production systems in the central grassveld of the Free State Region. 1982. S.J.L. Marais

PE.5623/48/3/1: Enterprise relationship: the economic evaluation of the utilisation of fodder crops with Merino sheep in the Fish River Valley. 1982. J. Jamneck

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PE.5623/48/4/1: Enterprise relationship: wintering of woolled sheep and other livestock in the northern Drakensberg grazing region. 1982. G. Grové

PE.5623/48/4/2: Enterprise relationship: profitability analysis of selected perennial crops in the Transvaal Region. 1982. W.F. Lubbe

SOIL CONSERVATION RESEARCH/GRONDBEWARINGSNAVORSING

Soil conservation/Grondbewaring

EROSION/EROSIE

CONSERVATION STUDIES/BEWARINGSTUDIES

D.5711/38/1/1: Erosion: the determination of soil losses associated with various tillage practices on various soil series established to pineapples in the East Lodon district. 1982. H.J. Smith

D.5711/38/1/2: Erosion: the determination of soil losses associated with various tillage practices and land use on soil series at Alexandria in the eastern seaboard areas. 1983. H.J. Smith

D.5711/38/2/1: Erosion: the effect of small structures in eroded watercourses. 1983. H.J. Smith

ENGINEERING/INGENIEURSWESE

LI.5711/51/1/1: Engineering aspects of soil erosion: aspects of gully erosion. 1983. A.H. McNaughton

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RESOURCE CONSERVATION/HULPBRONBEWARING

Planning of areas/Beplanning van gebiede

FARM PLANNING/PLAASBEPLANNING

MANAGEMENT/BESTUUR

D.5871/41/1/1: Planning of farms within the Alexandria Magisterial District of the eastern seaboard areas. 1984. P.C. Griffiths

AREA RUN-OFF CONTROL/GEBIEDSAFLOOPBEHEER

AGROHYDROLOGY/AGROHIDROLOGIE

V.5872/34/1/1: Area run-off control: investigation of adapted grass covers for waterways in RHFA 4053 of the Free State Region. 1982. H.J. van Dyk

MANAGEMENT/BESTUUR

D.5872/41/1/2: Area run-off control: planning of farms in the Zuney Valley, sub-cathment area No. 14200200 in the eastern seaboard areas. 1984. P.C. Griffiths

V.5872/41/1/1: Area run-off control: planning of farms in the sub-catchment area No. 10900104 in the Humansdorp Extension Ward of the eastern seaboard areas. 1984. J.P. van Zyl

ENTREPRENEUR DEVELOPMENT/ONDERNEMERS-ONTWIKKELING

PROGRAMMED EXTENSION: RESOURCES AND TECHNOLOGY
GEPROGRAMMEERDE VOORLIGTING: HULPBRONNE EN TEGNOLOGIE

Bushveld areas/Bosveldgebiede

MANAGEMENT FACTORS/BESTUURSFAKTORE

PERSUASION/OORREDING

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PERSUASION/OORREDING

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VELD

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BOTANY RESEARCH/BOTANIESE NAVORSING

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ANDER NUTTIGE PLANTE

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Biometric services/Biometriese dienste

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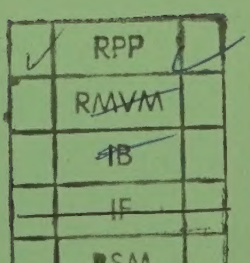
BIOMETRY/BIOMETRIE

BM.*11*212/43/1/1: Biometric analysis techniques as applied to data derived from soil analyses in Transvaal and Natal. 1983. B.E. Eisenberg


RPP
RMVM
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